THE

PRINCIPLES OF BOTANY.

THE

PRINCIPLES OF BOTANY;

Structural, Functional, and Systematic,

CONDENSED AND IMMEDIATELY ADAPTED TO THE USE OF

STUDENTS OF MEDICINE.

BY

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LONDON

SAMUEL HIGHLEY, 32, FLEET STREET.

1839.

LONDON:
J. GREEN AND CO., BARTLETT'S BUILDINGS, HOLBORN.

TO

JOHN EDWARD GRAY, ESQ., F.R.S., F.G.S., F.Z.S., &c.

AND PRESIDENT OF THE BOTANICAL SOCIETY OF LONDON,

This little Work is Inscribed,

WITH FEELINGS OF ESTEEM AND REGARD

BOTH FOR HIS WORTH AS A FRIEND AND FOR HIS VALUABLE LABOURS

IN THE DOMAINS OF NATURAL SCIENCE.

PREFACE.

It was not on account of any deficiency of works introductory to the study of Botany, that the author was induced to make public this little book, but because he thought he could present to the Student of Medicine *a more condensed view of the first principles of the science, combined with circumstances, and illustrated in a manner which would more immediately interest him,* than was done by any mere single text book with which the author was acquainted.

The numerous and important duties devolving upon the student during his sojourn at the various schools, and which is comparatively of so short a duration, render it expedient that the entrance to a science, (especially when, as a general rule, certain sciences are considered as subordinate to others, and this science, unfortunately, for it is useless to deny the fact, happens

to be one of them), should be as free as possible; so that the "pith and marrow," which the student is required to be acquainted with, should be attainable at once. That the dogmatic and half-sententious manner induced in the author, and imbibed by the reader, where this principle is acted upon, may lead to bad consequences, is no doubt true; and that the one may think he has performed all that he ought to have done, and that rightly, and the other that he has learned all he ought to have learned, and that soundly, whilst both may be egregiously mistaken, may be equally certain; but whilst there may be some who consider that there are existing necessities requiring the risking of such consequences as these and others attendant upon them, and that they may perhaps be balanced by other results, they will be tempted, probably like the author, to administer to such necessary requisitions.

It occurred to the author during the completion of the work, that he ought perhaps to have noticed several points he has left untouched, such as the elements of Phyto-geography and Phyto-geology, the chemical composition and relationships of elementary structures, etc., and to have given a short introduction illustrative of

the modes of dissecting and examining objects, more especially valuable for such analysis; but with regard to the former considerations, he has at present left them untouched; and with respect to the latter, as the author was well aware of the exigencies of time felt by those who, he imagined, might constitute the greater portion of his readers, he has thought it better to recommend to them the beautiful preparations to be obtained from Mr. Pritchard the optician; in which the elementary structure of the commonest or the rarest, the smallest or the largest vegetable body may be minutely examined. There are, on the other hand, some things which the author regrets not having had in his power to make use of for the present work, such as the paper of Schleiden upon Phytogenesis, of Unger upon Spermatic Animalcules, and the yearly report of Meyen, etc., all of which reached the author too late for administering to the utility in which he hopes the following pages will not be materially deficient.

Charing Cross Hospital,
October 1839.

ERRATA.

Page 33, line 6 from the top, *for* florets of the ring, *read* florets of the ray or ring.

" 42, line 9 from the bottom, *for* secondline, *read* secundine.

" 99, line 8 from the top, *for* deposited, *read* dissolved.

" 113, line 14 from the bottom, *for* acid, *read* acrid.

" 117, last line, *for* third head, *read* second head.

" 120. line 14 from the bottom, *for* Ifusoria, *read* Infusoria.

" 121, line 18 from the bottom, *for* GROWTH AND PROPAGATION, *read* GROWTH.

In some cases the diphthong œ has unfortunately been printed and passed over, as in Cœsalpinia, for instance, page 125, where it should be Cæsalpinia. Such instances the reader is requested to be indulgent enough to correct.

CONTENTS.

CONTENTS.

THE

PRINCIPLES OF BOTANY.

DIVISION I.

ANATOMY.

CHAPTER I.

Organized Vegetable Elements.

1. The organized *vegetable elements* are those primitive formations to which we can reduce the most compound structures of plants, but beyond which we can analyse no further; and these primitive formations are the results of, and obey and perform the laws of vital action.

2. These elements are two in number, *Membrane* and *Fibre*.

3. *Membrane* has in general the appearance of a tender, uniform, and diaphanous layer, separating from itself with an even edge, and is devoid of colour; when moist, appearing slightly stretched, but when dry, coming together and exhibiting wrinkles. Membrane *may* be found coloured, however, especially in many of the lower tribes of plants, as well as in the cuticle of some of the higher orders. The action of the mineral acids upon membrane is in general destructive, except, according to Meyen, upon the membrane forming part of the structure of the grains of pollen.

4. *Fibre* is a thread-like substance of an excessively small diameter, more generally cylindrical in development than otherwise, and void of colour, and undoubtedly often branched or divided, though it is denied by some; it occurs with membrane in which no fibrous structure can be detected, though often seen independently of it.

5. All the *elementary structures* of plants have their origin in one or other, or both of these two elements; and may be divided into the *cellular, fibrous, and vascular tissues.*

CHAPTER II.

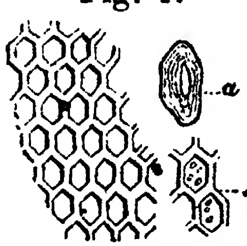
TISSUES.

Cellular Tissue.

6. *Cellular tissue* is the most generally diffused form of elementary structure throughout the vegetable kingdom, entering greatly into the composition of the more highly developed individuals, and of those far down in the scale, being the sole constituting substance.

7. *Cellular tissue* is both *membranous* and *fibrous*, but the membranous form is by far the more common. This form existing in the state of pith is the most suitable for examination, and presents the appearance of a number of cellules in close approximation with each other; the cellules being generally of an hexagonal shape, and separated from each other by the union of their walls. The walls of cellular tissue are therefore composed of two layers, and there are no *visible* means of communication through these separating media from cellule to cellule.

Fig. 1.



8. The walls of a single cellule, though often very

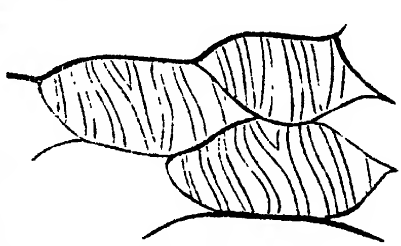
thin, sometimes become very thick (as seen at *a* fig. 1.); this arises from a superposition of layer upon layer, always *within* the one first formed; by this continued superposition, the vacuity of the cellule is known to become obliterated.

9. The membrane forming the walls of cellular tissue, is sometimes marked with a number of circular or oblong spots; these were once supposed to be pores, but are now looked upon as *thinings* merely of the membrane in certain places; there is undoubtedly a deprivation of the substance of its texture, but no complete solution of continuity. (Fig. 1. *b*.)

10. The general laws regarding the development of this form of tissue are not yet settled, though the rapidity of its increase is known to be considerable; Dr. Lindley calculating that the cellules of a Bovista were increased at the ratio of nearly 4,000,000,000 per hour.

11. Many other shapes of cellules besides the hexagonal, are described in books, but most of them are the result of pressure upon more aboriginal forms, and are no evidences of any peculiarity as regards original structure. The normal types of the cellule are the spheroidal and thread-like.

12. *Fibrous cellular tissue* is that form of structure in which fibre, in various states of arrangement and direction, is combined along with true membrane to produce a formation distinctly cellular. This structure is evident in certain tropical Orchideous plants, and



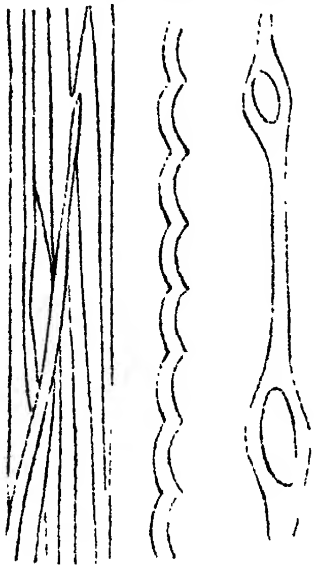
in different parts of the organs of fructification of many other individuals

Fibrous Tissue.

13. *Fibrous tissue*, or *woody fibre*, are terms adopted, perhaps, more for the sake of convenience, than from our being able to limit to them particular forms of

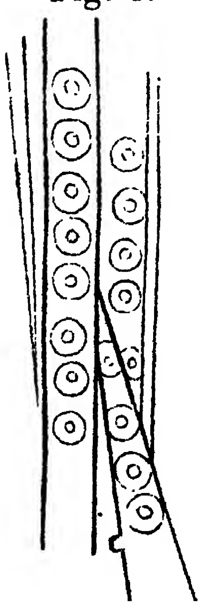
structure, for some generally included under these definitions run very closely indeed into certain modifications of *vascular tissue*.

14. *Fibrous tissue*, or *woody fibre*, as generally understood, consists of thin long membranous tubes adhering together in pretty close fascicles: the size of the fibre varies in circumference and length, and is generally conical or accuminate at its apices. The surface of fibre though mostly even is not always so, but presents irregularities which are caused by the pressure of other structures upon it; and the fibre, though generally hollow all the way down, sometimes seems hollow only at intervals, and often becomes considerably dilated there.



15. Though woody fibre is generally devoid of all marks upon its surface, in some plants it presents very peculiar appearances independently of any thing resulting from pressure of contiguous bodies. These appearances, the nature of which it is exceedingly difficult to determine, are well seen in the tribe Coniferæ or pine family, some looking upon them as pores, others as thinnings, and some as bodies adhering to the fibre. The most probable view appears to be that they are depressions in the walls of the fibre, the centre of which depression is either porous or else thinner than any other portion. It often appears as if something were lodged in these depressions.

Fig. 4.



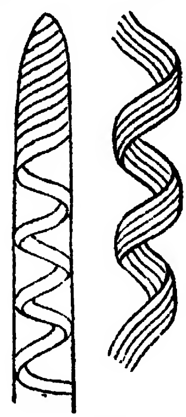
16. In the organs of generation in certain plants, fibre is seen assuming very peculiar dispositions and arrangements, which constitute a variety of fibrous cellular tissue, according to some.

17. *Fibrous tissue* constitutes a great portion of the woody matter of all plants as well as the bark, and is the formative material in all hempen goods.

Vascular Tissue.

18. *Vascular tissue* consists of two forms, *spiral vessels* and *ducts*, though transitional states of one form into the other undoubtedly can be seen.

19. Spiral vessels are *simple* or *compound*. The best definition of this structure is a modification of Links—spiral vessels are more or less regular cylindrical tubes formed by spirally wound fibre *within* a tender membrane.



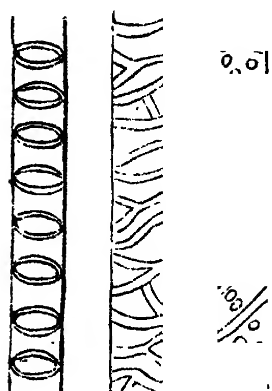
20. *Simple spiral vessels* are those in which *one* fibre alone is twisted within the membrane; *compound* ones in which there are *two or more.*

21. The fibre of a spiral vessel is most probably *solid,* and the termination of the vessel *conical* or accuminate.

22. *Spiral vessels* exist chiefly as a layer of tissue (called the medullary sheath) immediately surrounding the pith; they are found in the roots of a few exogenous as well as endogenous plants, and although more immediately proper to the true flowering plants, have likewise been found in Ferns and the capsules of young mosses; and, it must be remembered, are few and small in the tribe of the pines or Coniferæ.

23. *Ducts* are of two kinds, *ducts* and *proper* ducts.

24. The *ducts* are seen under three states; the annular (*a*), the reticulated (*b*), and the dotted (*c*); and it is probable these different forms have their origin only in certain metamorphoses of spiral vessels.



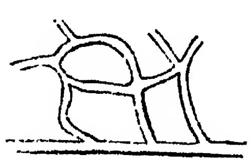
a *b* *c*

25. *Annular ducts* consist of a number of rings placed at intervals within a membranous tube often of a very considerable diameter; they are common in succulent stems like that of the Balsam, and are met with in the root.

26. *Reticulated ducts* have these rings broken up, and the divided portions often anastamosing one with another; they are met with where the annular are seen, and an intermediate state of them approaching to the next form is seen in Ferns.

27. *Dotted ducts* seem to connect vascular tissue with woody fibre, and are composed of membranous tubes with tranverse or crossing rings, between which are placed little bodies very similar to what we see on some true woody fibre.

28. *Proper ducts* are thin membranous tubes, sometimes anastomosing within each other, and frequently running parallel with the veins of leaves, in which organs they are most easily seen, especially in plants having lactescent juices. The tube is plain.



Besides these forms of elementary structure, there are certain pseudo ones which depend for their origin upon the previous existence of one or other of those which we have already mentioned. These are, *intercellular substance*, *intercellular passages*, *air passages*, *air cells*, and *receptacles of secretion*. Intercellular substance is a material of a very doubtful nature which intervenes between the walls of the cellules of imperfectly connected tissue, and the rest result from spaces being left

between the cells of such tissue which vary in form, size, and purpose, as the terms employed designate.

CHAPTER III.

ORGANOGRAPHY.

29. We have spoken of the elementary structures, out of which all the other more compound organs of plants are formed, and of which compound structures themselves we have now to speak.

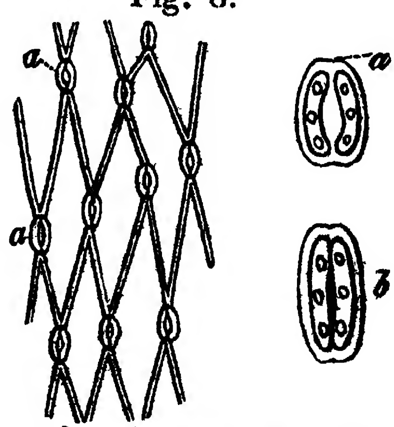
Epidermis, &c.

30. The *epidermis* is a thin layer composed of cellular tissue, the walls of whose cellules are closely approximated to each other, and form by their union what are termed reticulations.

31. This *cellular layer* exists externally over all portions of the surface of plants, save in two places only.

32. These places are the extremities of the radicles, (or fibres of the root) and the stigmatic surface, (or extremity of the female organ of generation) in which the external covering is somewhat modified.

Fig. 8.



33. According to some, the *epidermis*, or skin of a plant, is covered externally by a thin membrane called *cuticle;* but it is highly probable that this cuticle is

caused only by a thickening of the external layer of cellules composing the epidermis itself, and a partial separation of them from the other layers.

34. On the *epidermis* of plants exist a great number of little pores or openings presenting a peculiarity of structure, and which are known by the name of *stomata*.

35. *Stomata* are formed thus, (see fig. 8, *a*.) Between certain of the cellules of the epidermis there is an opening of the layer which communicates with a hollow and air-cells beneath; above this opening of the epidermis, are placed two little bodies of an oblong shape, which, when adhering close together, cover over the opening, so that no communication between the air-cell and the external air exists (*b*.) These little bodies can, however, separate from each other in the centre, remaining connected together only at their extremities, leaving as it were an oval space between them, and partially uncovering the opening in the epidermis over which they are placed.

36. The nature of the stomatorial bodies themselves seems to be glandular, and various modifications of structure and form are to be seen in different plants.

37. *True stomata* exist chiefly on the epidermis of *leaves*, especially on their under surface, though they are found in other parts as well. They seem disposed in most cases without regard to much regularity, though in others, as in Begonia, the reverse holds good. Their number on a given space of epidermis varies, for in *Pinus halepensis*, 19 were found, and in *Citrus aurantium*, 2846.

38. *Stomata* do not exist in all plants; it is said never in those constantly growing under water, or in those growing in darkness: they are few and small in the Pine tribe, and likewise in Grasses. On the epidermis of many plants, other openings exist, differing in their conformation from true stomata; such are seen in Nuphar: and in Nerium oleander are large cavities, from whose sides spring a number of hairs, no true stomata being present. In the Ferns and Moss allies, stomata-like structures are also to be found.

39. *Hairs*, in all their varieties from Down to Bristles, are other appendages of the epidermis of plants, and are formed of one or more cells of cellular tissue developed in an elongated form, and sometimes having, as in the Nettle, a glandular apparatus at their base.

40. *Prickles* are modifications of hairs in which continued deposition of layer upon layer of cellular tissue has gone on, and the cells of the tissue become continuous with one another.

41. *Glands* are cells of cellular tissue which are sometimes enlarged and sometimes not, and arranged in an aggregate or simple manner as appendages of the epidermis, but which are chiefly characterized by their peculiar [illegible]es. Sometimes they are sessile upon the surface of the epidermis, and at others have an elongated cellular stalk. There is a particular kind of gland called the Lenticular; these glands are seen upon the external surface of young twigs and branches, especially of the Willow, they have been supposed by some to be root buds which, when placed in water, gave origin to such organs. This view has been controverted. The origin of them appears to be from the external portion of the bark, and they are destitute of any true communication with the internal layers of it.

Special Divisions of the Axis.

Root.

42. *A root* is characterized by the following circumstances: by having no development of appendages upon its surface like leaves or scales; by its epidermis being destitute of stomata, and its divisions being irregular and not proceeding from buds. In most roots no pith exists; they are mostly destitute of true spiral vessels, and they do not exhibit the colour green: to these, however, there are exceptions to be found.

43. The root is divided into two portions, the *caudex* or body, and *radiculæ* or fibres.

44. Two modes of development are seen taking place in the roots, the elongated and the spheroidal.

45. To the first or elongated kind, all more or less *fibrous* or cylindrical roots like those of Grasses, &c., can be reduced; and to the second or spheroidal, all such roots as are seen in or approach to that of the Dahlia.

46. The *radicles* are merely subdivisions of the body of a root, the cellular tissue of whose extremities is somewhat modified to that of the rest. It is often of a greenish yellow colour, though it has been seen red, and its surface is covered with numerous papillæ.

47. The *radicle* is an essential part of the root, and its extremity has received the name of *spongiole*.

48. *Annual roots* die away after the close of the first vegetating season.

49. *Biennial roots* perish at the close of the second season of their producing herbage, and the first of flower or fruit.

50. *Perennial roots* last for many seasons, though all their herbage, &c., may die every year.

51. Cultivation of some annual roots in hot climates will cause them to become perennial, and the removal of perennial ones of hot climates into cold ones, cause them to become annual.

52. The root, except in what has been mentioned in anatomical structure, differs little from the stem of the plant; in some, as in those where the evolution tends to the spheroid, there is a very great degree of development of cellular tissue.

Stem, &c.

53. Underground parts of plants have been called roots which are really not so; these are mere enlargements of the stem, or certain appendages of it answering a purpose peculiarly their own.

54. The development of the stem is in general cylindrical, and its direction perpendicular, and these always exist in the earliest stages of its growth. Sometimes, however, the development becomes spheroidal or globose, or the direction horizontal, and these take place under or near the surface of the ground.

55. From the more or less spheroidal *development* of the base of a stem, we have produced the *cormus* and the *tuber*.

56. The *cormus* seen in the Colchicum and Crocus, is an enlarged base of their stem, containing along with much cellular, both fibrous and vascular tissue, and from which, in many cases, the new plant arises in the spring of the year.

57. The *tuber* is seen, for instance, in the Potatoe, which is a development of cellular tissue increased to a very great extent in the lower part of the stem, and which possesses buds or eyes capable of giving rise to new individuals.

58. The *cormus* belongs more especially to monocotyledonous plants.

59. From the more or less modified *direction* of a stem under or near the surface of the ground, we have produced the *caulis repens* and its modifications, and the *caulis procumbens* and its modifications.

60. The *caulis repens*, or creeping stem, is a stem running along beneath the surface of the ground, and sending out rootlets and plants at certain intervals, as in Couch-grass, or else becomes very much thickened, and lies upon the surface of the earth, when it constitutes a *rhizoma*, as in the Sweet flag, (*acorus calamus*.)

61. The *caulis procumbens*, or lying stem, has various modifications; the whole stem or plant sometimes lies along the surface of the ground; it is then simply *procumbent*: sometimes the end of the stem produces roots and a young plant, as in the strawberry; it is then *sarmentose*, and the trailing stem is a *runner*, &c.

62. Independent of the *cormus* and *tubers*, there are

certain appendages of the stem to which the term root is popularly applied. These are the *tunicated* and *scaly bulbs*.

63. These bulbs are spheroidal, laminated, or scaly bodies, arising at the bottom of the stem just below the surface of the ground, and from which, when separated from the parent stem, a new individual is capable of being produced.

64. *Tunicated bulbs* are composed of concentric hollow spheres laying one upon the other; the inner spheres are of a firm texture, whilst the outer ones are not. They are seen in the Onion and Squill.

65. *Scaly bulbs* have their pieces imbricated on each other, the external ones being as firm as the rest. They are seen in the Lily.

66. All flowering plants possess, or have at one time possessed, more or less of an ascending axis or stem; in some, however, this stem is not very apparent; the plant is then called *acaulis*. To the ascending axis of Grasses and similar plants, the term *culmus* is applied, and to that of Palms, *stipes*.

67. In considering the structure of the stems of plants for the sake of convenience, and because it is justified by high authority, we shall divide them into three divisions, supposing that a distinct type exists for each, and so examine the conformation of each division separately, reserving for the physiological portion of this subject the question of whether we are able to do so with propriety.

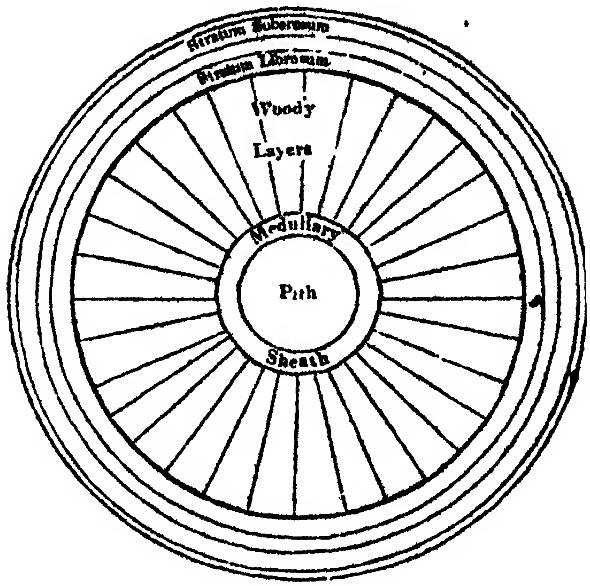
68. Stems may be divided into three kinds; the Dicotyledonous and Exogenous, the Monocotyledonous and Endogenous, and the Acotyledonous.

Dicotyledonous and Exogenous Stems.

69. On making a section of a stem of this division, whose development is both mature and normal, (say of

4 or 5 years growth) we observe the following circumstances:

Fig. 9.



70. In the *centre* of the stem is seen the *pith*; around that a thin layer, the *medullary sheath*; next come the more or less *woody layers*, traversed by lines radiating from the centre of the stem to its circumference called *medullary rays*; and, lastly, the *bark*; the whole structure is harder at the centre than at the circumference.

71. Now all stems exhibiting such structure are termed Exogenous or dicotyledonous, and examples are to be found in such plants as the Oak or the Elm.

72. The *medulla*, or pith, is a continuous column of cellular tissue, extending from where the stem and root join each other to the extremities of the twigs and branches. When young it is of a greenish white colour, and its cellules are filled with watery matter. At about the third or fourth year, the pith arrives at the condition in which it will remain during the whole period of its existence; and as a general rule we may

say that no diminution of it takes place by the pressure of parts around it.

73. This *central system* of an Exogenous stem is composed alone of cellular tissue—those cases in which other tissues have been noticed in the pith, will be mentioned hereafter.

74. In some plants the pith disappears as the vegetable grows, the stem of which becomes quite hollow; this arises from the rapid growth of the surrounding structures, when young, being too great for the pith to keep up with; the result of which is, the pith is torn to pieces. This is seen in the *common Hemlock*.

75. The *medullary sheath* is a thin layer of a green colour closely surrounding the medulla or pith. This sheath is composed chiefly of spiral vessels, and is the first formed of the vascular system of a plant.

76. The *woody layers* are composed of vascular and fibrous tissue, and exist in the shape of concentric zones between the medullary sheath and inner layer of the bark.

77. These zones of woody matter vary in number according to the age of the stem; as a general rule for our climate, we may say that there is a zone of woody matter for every year the plant is old.

78. The innermost zones of woody matter are termed the *duramen*, or heart wood, and outermost or last formed zones, *alburnum*.

79. The *duramen* is harder than other parts of the wood, and often contains a great deal of colouring matter, whilst the *alburnum* is younger and consequently softer, and of a lighter colour.

80. The *medullary rays* are laminæ of cellular tissue which traverse the woody layers from the centre to the circumference, being connected in the centre with the tissue of the medulla, and at the circumference with that of the bark.

81. These rays do not always run unbroken and continuous, but become incomplete as in the Coniferæ.

82. The *bark* lies external to the woody layers, and is composed originally of four layers.

83. The *epidermis*, the *stratum suberosum*, the *stratum parenchymatosum*, and, lastly, the *stratum librosum*.

84. The *epidermis* is the external layer of the bark, and is formed of a simple layer of small cellules having pretty thick walls, and covered with stellate hairs. It is continuous with the cuticle of the leaves, and is not found on the old branches or trunk.

85. The *stratum suberosum*, or corky layer, lies beneath the epidermis, and is composed of from three to five layers of colourless cellules with thin walls, and devoid of granules. In some plants this layer scarcely ever exists *perfectly*; in others, it becomes highly developed, as in the Cork Oak. In our own country, the Plane tree approaches nearest the Cork in an evident development of the *stratum suberosum*. This layer of the bark does not often attain a very great thickness, and is easily destroyed.

86. The *stratum parenchymatosum* forms the third layer from the circumference, and is composed of cellular tissue, containing a good deal of green colouring matter, though sometimes having colourless cells filled with crystals.

87. The *stratum librosum*, or liber, is the fourth and last layer of the bark. This layer is not always to be separated from the last mentioned one, except in old branches or trunks; it consists internally of fibrous tissue, and externally of cellular. In consequence of the twining course of the bundles of the fibrous tissue of this layer, there are formed regular interfibrillar spaces, which give to the whole a pretty net-like appearance, and the meshes of this net-work are filled with parenchymatous cells which may be looked upon as the medullary rays of the bark. (*Meyen, Neues system, &c.*)

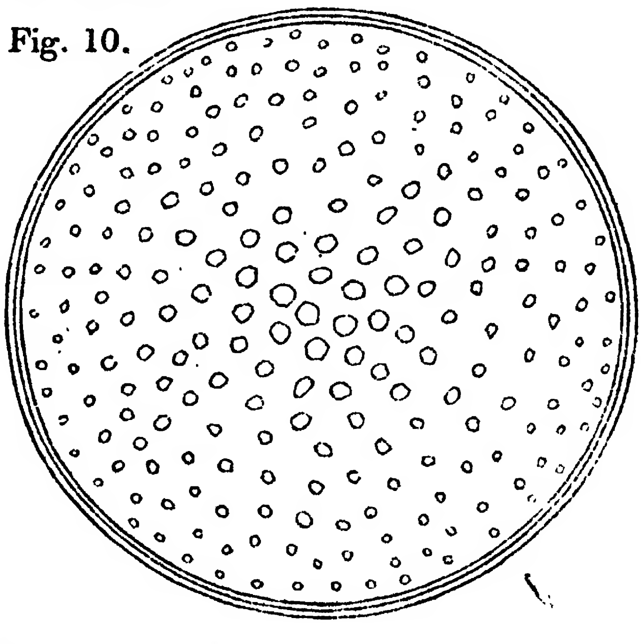
88. Considering an Exogenous stem as regards elementary structure, we may say that its cellular system is seen chiefly in the pith and part of the bark, its vascular in the medullary sheath and internal portions of the woody layers, and its fibrous in the external parts of the woody zones and inner portion of the bark.

89. The vascular system of Coniferous stems is very destitute of true spirals, and their woody tissue chiefly consists of that peculiar fibre we mentioned before, (15.)

Monocotyledonous and Endogenous Stems.

90. On making a section of a stem of this division, instead of finding a central cellular system or pith, around which is concentrically arranged a vascular and fibrous one in close connection with each other, traversed by medullary rays, and harder at the centre than the circumference, as we saw in the other, we find the following:

Fig. 10.



91. There is a uniform mass of cellular tissue filling the stem, through which distinct bundles of woody fibre, encircling vascular tissue, are seen running down, but which are not closely connected with each other, the whole being enclosed in many cases within a mere epidermis, but in others perhaps within a modified bark; the whole of the structure being harder at the circumference than it is at the centre.

92. Now all stems having these characters are called Endogenous or Monocotyledonous, and are to be found in such plants as the Cane and the Lily.

93. The *cellular tissue* of these stems, as in some of the Palms, has sometimes its cellules very much developed towards the centre, and contains a considerable quantity of amylaceous matter.

94. The *woody bundles* do not always run down the stem in a regular manner, but often cross each other and go down obliquely, as in the Palms, and often approach very close together.

95. In some of these stems, as in the Grasses, there is a vacant place in the centre, and the woody bundles are found all at the circumference; originally this was not the case. (For further considerations see physiology.)

Acotyledonous Stems.

96. Many of the lower tribes have no true axis at all, their development being perfectly plane, as is seen in many Lichens, Algæ and allied plants; in those, however, in which a sort of stalk or stem to such expansion exists, the structure of it is merely cellular. In the *Fungi*, the term *stipes* is applied to what otherwise might be called their stem; the structure is cellular. It is in the foliaceous Mosses that a stem is first quite evident, and here they are composed of cellular tissue, the cells of which are elongated or cylindrical. In the *Ferns*, the *true* stem of which is, in our country, generally below the ground, although in tropical ones rising many feet above it, is composed both of cellular fibrous and vascular tissue; when cut across, bundles of woody and vascular tissue are seen—often very irregularly disposed,—which run down the stem: in some cases the larger bundles are disposed cylindrically, and consist of fibrous tissue containing within it both spiral vessels or modifications of reticulated ducts.

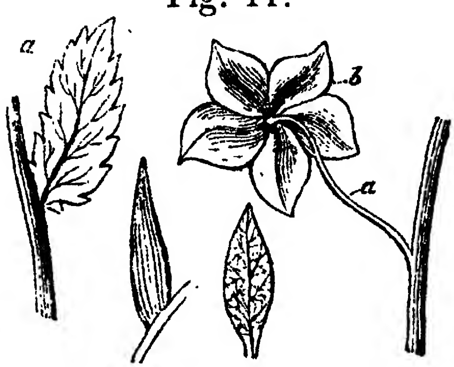
The appendages of the stem are now to be described.

Leaves.

97. A leaf is composed of two systems, a fibro-vascular, and a cellular system.

98. The *fibro-vascular* is first formed and is composed of spiral vessels and woody fibre derived from the medullary sheath; a fascicle of this tissue separates from the sheath and directs itself outwards to the circumference of the stem, and in doing so becomes enveloped in some cellular tissue it pushes out from the bark, when it makes its exit at the circumference; this bundle either expands at once into a leaf which is then called *sessile*, or the bundle is yet further prolonged as a *bundle* for a variable length before it expands into a *lamina*, and the leaf is then called *petiolate*, and the prolonged bundle a *petiole*. In the first case the leaf consisting of one part, the *lamina* (*a*); the second of two, the *petiole* (*a*), and *lamina* (*b*).

Fig. 11.



99. The further arrangement of structure in a leaf, is the following:—The fibro-vascular system is distributed over the lamina by anastomosing ramifications forming what are termed the *veins;* and there are two systems of venation, the *parallel* and *reticulated* (fig. 11), the first occurring in leaves on monocotyledonous, and the other in those of dicotyledonous stems. As soon as the ramifications are complete upon the upper surface of the leaf, they turn back, and beneath, to ramify on the under surface, returning to the petiole, and becoming continuous with the bark: now between these different ramifications is contained the *cellular or parenchymatous system.*

100. The disposition of the parts of the parenchymatous system is this: covering over the whole lamina of the leaf is the epidermis; beneath this is the true pa-

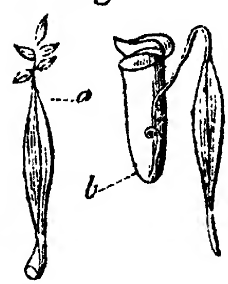
renchymatous layer, the cells of which are different in form in the layer next the under epidermis, to what they are in those beneath the upper; aud between these two layers is situated the diploe, in the cells of whose tissue is contained organic and colouring matter.

101. The *petiole* consists of two larger fascicles of fibro-vascular tissue, one of which is continuous with the medullary sheath, the other being the returned and collected fibres from the lower surface of the lamina, is continuous with the bark. They are covered by epidermis.

102. The development of the petiole is sometimes so abnormal as to simulate in appearance the lamina of a leaf, or else to give rise to structure of more particular configuration.

103. *Phyllodium* is the term applied to such a plane development of the petiole, as at (*a*).

Fig. 12.



104. *Ascidium* to such formations as the pitcher of Nepenthes (*b*).*

105. When a petiole at once expands into a lamina without subdividing (fig. 11.), the leaf is called *simple*; when the petiole subdivides into secondary petioles, each bearing separate laminæ, the leaf is *compound*.

Fig. 13.

Pinnate. Triternate. Ternate.

* From some late observations of Morren, it would seem that the *pitcher* is to be considered rather as a modified *lamina* than *petiole*.

106. *Compound leaves* may be also

Pinnate and Ternate, &c. &c.

107. When the edges of the lamina are not cut, the leaf is called *entire;* but when the reverse is the case, the leaf is said to be *divided.* (Fig. 11.)

108. When the petiole seems inserted into the middle of the lamina, (fig. 11,) it is called *peltate;* when the bases of two opposite leaves become united together so as to form one lamina, they are said to be *connate*; and when many leaves are placed in a circle around the same point of the stem, they are called *whorled.*

109. Leaves may be glabrous or smooth, downy and hairy, &c. &c.

110. *Persistent,* when they continue living through two or more winters.

111. *Deciduous,* when they fall before new ones appear.

112. The term *caducous* is given to those that fall soon in the season; and the term *marescent,* to those that wither before they leave the tree.

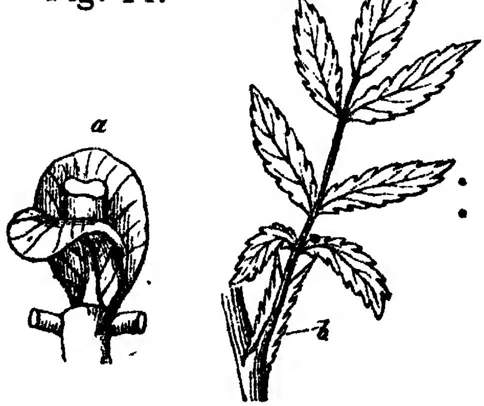
Stipulæ and Bracteæ, &c.

113. There are certain modifications of leaf-like expansions known under the terms of stipulæ and bracteæ.

114. *Stipulæ* occur under two forms, the *solitary* and *connected.*

115. The first are seen in the Cinchonas, where they arise from the stem itself, and are destitute of connection with the petiole of a leaf (*a*). The other is seen in the Rose, where they exist as appendages to the base of a general petiole (*b*).

Fig. 14.



116. *Stipulæ* seem to be modifications of leaves; in their solitary forms being rudiments

of the simple leaves of the plant on which they are found, as on Cinchona; and in their connected one, rudiments of the leaflets of the compound leaves of the plant, as on Rosa.

117. An *ochrea* is a solitary stipula, whose edges are united together so as to form a sheath around the part near which it is developed, as in *Polygonum*.

118. Stipulæ are not common on *monocotyledonous* or *endogenous* plants.

119. *Bractea* is a term rather inconclusive as to what it comprehends within its meaning; but, as a general rule, all foliaceous expansions placed between the common leaves and true external floral envelope, are *bracteæ*.

120. Sometimes many bracteæ are developed very close together, becoming imbricated one upon the other, and are placed immediately beneath the flowers, as in the common Daisy; this constitutes an *involucrum*. At other times they become consolidated together, forming a *cupula*, as in the Oak.

121. Other forms, deemed bracteæ by some, will be found amongst the floral envelopes.

122. There are certain little bodies called *buds* which vary in their nature, and appear upon different parts of the divisions of the stem; some being placed in the axillæ of leaves, and others upon the leaves themselves; some giving rise to new branches, others to leaves. In true leaf buds the young leaves are rolled up in various manners; in the Apple they are *involute*, in the Rosemary, *revolute*, in the Wall flower, *convolute*, and *plaited* in the Palms.

123. *Tendrils* and *spines* are other appendages often met with on plants.

124. *Tendrils* are filiform bodies, which are mostly to be met with on plants having feeble or climbing stems, and by their twining spirally around contiguous objects tend to support the otherwise falling plant; they are abortive states of different parts of the axis, their *situation* on the plant showing what they are abortions of.

125. *Spines* are sharp-pointed organs, which must be looked upon as merely abortions of a bud ; the spines of the Sloe tree are convertible into branches, if that tree be transplanted into a rich soil. They are likewise continuous with the woody tissue of a plant, and thus differ from prickles.

Floral and Reproductive Structures.

126. The organs included under this head, are the *true floral envelopes*, the *generative organs* and *fruit*.

127. Floral envelopes and generative organs constitute a flower, which is composed of the *calyx* (*a*), the *corolla* (*b*), the *stamens* (*c*), and the *pistil* (*d*), in those cases in which all the parts are fully developed.

Fig. 15.

128. *Of the floral envelopes.* If we take the flowers of a cowslip we shall be able to separate its foliaceous structure into two portions; an outer or green covering (*a*), the *calyx*, and an inner or yellow one (*b*), the *corolla* ; both taken together are called the Perianthium, and the flower itself is termed *Dichlamydeous*.

Fig. 16.

129. All flowers, however, have not two distinct coverings, and such are termed *monochlamydeous ;* and when none exist at all, it is *achlamydeous*.

130. The *calyx*, or outer floral covering, is generally of a green colour, and consists either of one continuous foliaceous piece, or else is composed of several separate pieces.

131. The pieces of which a calyx is composed, are termed *sepals* or *phylla*.

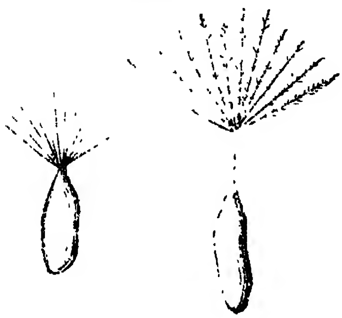
132. The calyx of the Cowslip is of one piece, and is therefore termed *monosepalous*, and the calyx of the Mustard, of many, and is termed *polysepalous*. All mo-

nosepalous calyces were originally polysepalous, but the edges of the pieces have become united.

133. When the pieces of a calyx are joined nearly all the way up, but not entirely, the calyx is said to be *toothed;* when half way up, *cleft;* and when a little above the base only, *parted.*

134. In such plants as the Dandelion, which belong to the natural family, Compositæ a peculiar modification of calyx exists. The calyx is closely united to the body of the fruit, at the top of which it elongates, divides, and spreads into a white feathery-looking substance called the *pappus.* This is *sessile* when there is scarcely any elongation previous to division, *stipitate* when there is.

Fig. 17.



135. The calyx in some plants, as in the Labiatæ, has its *limb* so divided as to represent an upper and an under lip; the calyx is then said to be *bilabiate,* and a little below the orifice is the *throat.*

Fig. 18

136. There are two terms often met with, namely—"*calyx superior,*" and "*calyx inferior.*" which require explanation. Of the different portions of which a flower is composed, the calyx is formed lowest down on the axis, and the pistil the highest up, however close they may appear together; now when the calyx appears evidently to arise *below* the base of the pistil, (called the ovarium,) it is said to be *inferior,* (as in fig. 30); but when it adheres all around the ovarium, and seems to arise from *above* it, it is called *superior.* But from what we first stated, we must remember that its true origin is inferior, whilst it is only *apparently* superior (fig. 31), to the base of the pistil.

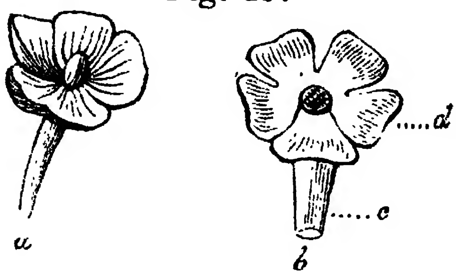
Dr. Lindley remarks, "that the calyx may be superior in consequence of the cohesion of the ovary with the inside of an excavated pedicel, and not with the calyx itself, as in Eschscholtzia."

137. The *corolla*, the inner floral envelope in dichlamydeous plants, is generally of a delicate texture and highly coloured, and larger than the calyx.

138. The foliaceous pieces of which a corolla is composed, are termed *petals*.

139. When these pieces continue distinct from each other, the corolla is called *polypetalous*, as (*a*), but when they are united, *monopetalous*, as (*b*). The cylindrical part of a monopetalous corolla is called the *tube* (*c*), the expanded portion the *limb* (*d*).

Fig. 19.



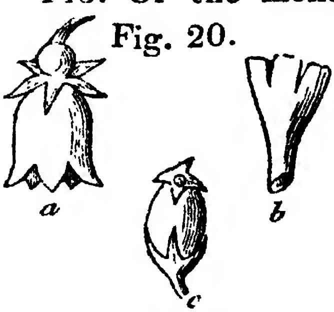
140. A monopetalous corolla may be *regular* or *irregular*.

141. *Regular* when its figure is uniform, its divisions equal, and these regularly placed around an imaginary axis, as at fig. 20.

142. *Irregular* when the reverse, as at fig. 21.

143. Of the monopetalous *regular* corolla we may have—

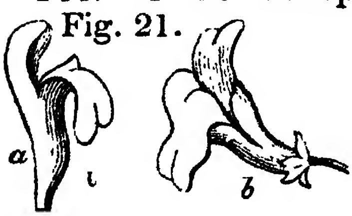
Fig. 20.



The Campanulate (*a*).
Infundibuliform (*b*).
Hypocratyform (fig. 19, *b*).
Rotate, the same as the last but the tube very short.
Ventricose (*c*).

144. Of the monopetalous *irregular* corolla we may have—

Fig. 21.



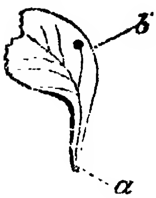
The Ringent or Labiate (*a*).
Personate (*b*).

145. In the *ringent* corolla the irregular lips are wide apart from each other, the upper one being often vaulted, is termed the *galea* or *helmet*.

In the personate corolla the lips are *appressed*.

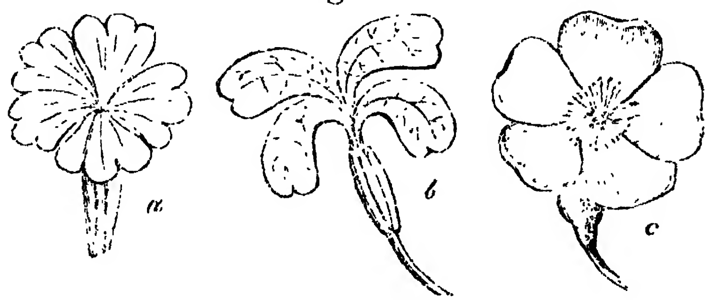
146. A *polypetalous* corolla may be *regular* or *irregular*, the petals of which it is composed are divided each into two parts; the *unguis* or claw (*a*), the *lamina* or limb (*b*), the former of which is not always very evident.

Fig. 22.



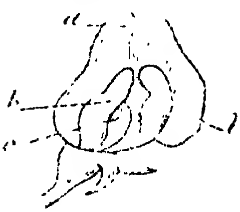
147. Of the polypetalous *regular* corolla we may have—the Caryophyllaceous (*a*), Cruciferous (*b*), Rosaceous (*c*).

Fig. 23.



148. Of the *irregular*—The Papilionaceous. This has five petals, the vexillum or standard (*a*); the alæ or wings (*b b*), and the carina or keel of two pieces (*c*).

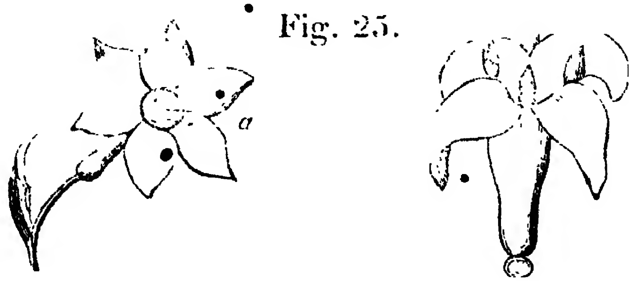
Fig. 24.



149. There are some other forms of the irregular polypetalous corolla, as seen for instance in the Monkshood; but these cannot be well reduced to any particular order.

150. There are certain structures often seen connected to the corolla, called appendages of it, and to which Linnæus applied the term nectaria, such as the *corona* of the Narcissus (*a*), *foliaceous scales* at (*b*).

Fig. 25.



The *calca* or spur is a tubular elongation of the regular petal itself; the above are superadded abortions of other petals or of stamens.

151. In *monochlamydeous* flowers, or those having one floral envelope only, it is not always easy to determine whether it is a calyx or a corolla. Though the calyx is generally of a green colour, of leaf-like appearance and texture, continuous with its stalk or peduncle, and its divisions opposite stamens, there are exceptions; and even where both calyx and corolla exist, in some cases we cannot put a limit between the two, the calyx seems to pass into the corolla, and the corolla into the calyx; and though the corolla is mostly coloured and delicate in texture, and its divisions alternate with the stamens, we have exceptions to these, so that when one envelope only is present, its true nature may be doubtful. In most of such cases we may look upon the covering as being rather of a corollaceous than a calycaceous nature. The restricting of the term *perianth* to such a structure, would prevent an application of a *wrong* term, though it might serve, as Dr. Lindley well remarks, as an evasion of the task of ascertaining its true character.

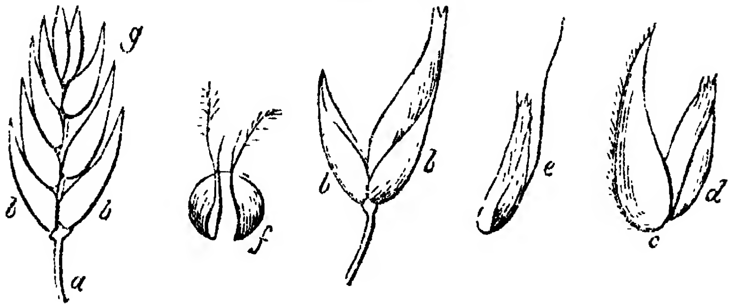
152. The *spatha* is a form of perianth consisting of a large, more or less coloured, foliaceous expansion, which serves as a general floral covering to what is termed a spadix. (See fig. 28, *b*.) Perhaps, in most cases, this is more truly a bractea.

153. The already described forms of floral envelopes are foliaceous or *petaloid;* there exist others which are termed *glumaceous*, such are seen in the Grasses. They are considered by many as being more of the nature of bracteæ than of calyx or corolla, and undoubtedly some portion of what we have to describe is so, but the others appear to me so analogous to the forms of structure we are at present speaking about, that we shall notice them here.

154. Take a cluster of flowers (*a*), (which is here called a *locusta)*, say of the common reed, *(arundo)*, and

pull away all of it except the scaly-looking pieces at the bottom (*b b*).

Fig. 26.



155. These pieces (*b b*) which are the calyx, glumes, tegmina, of different authors, are to be considered in the light of true *bracteæ*; in some cases there is only one piece present, and the bractea is then said to be *one valved.*

156. Now within these valves of the bracteæ were contained the flowers you pulled out, which, in this case, were 5 or 6 in number. The bracteæ are then called *many-flowered*; sometimes there are more flowers, at others many less, the bracteæ being often only *one-flowered.*

157. Take one of the flowers (*g* in *a*, fig. 26) and separate it from its centre, and you will find it composed of two scaly pieces, (*c*, *d*,) the *inner* scale (*d*,) being somewhat pressed within the other; these are the corolla, perianthium, paleæ, &c., &c., of authors. They are to be considered as true floral envelopes, and as they form only one covering, the term *perianthium* appears to be the best; (*c*,) is the outer valve, and (*d*,) the inner valve of the perianth.

158. Sometimes the outer valve of the perianth has a bristle-like appendage, (*e*,) this is called an *arista* or awn, the perianth then being called awned or aristate.

159. Within the valves of the perianth you will find at the swelled base of the feathery-looking *stigmas*, two

or three membranous pieces, (*f*,) ; these are the nectaria squamulæ, &c., &c., of authors. In this case these little scales are somewhat long and membranous; in others, they are smaller and thicker.

160. In the *carices* or sedges, the bracteæ are one-valved, and situated beneath each perianth, the edges of the valves of the perianth being united together so as to form an *urceolus*.

161. Although it has been said that the true floral envelopes, along with generative organs, constitute a flower, yet as these latter organs may exist without true calyx or corolla, the coverings that may be present being truly bracteæ, the term *naked flower* has been applied to them.

Inflorescence.

162. The modes in which flowers are arranged upon a stem or its divisions, are termed their forms of *inflorescence*.

163. The part by which a flower is attached to the *main stem*, is termed the *peduncle*, (fig. 28, *f*.) ; when a peduncle is divided, the divisions bearing the flowers are called *pedicels*, (fig. 28, *i*.)

164. When the peduncle bearing the flower seems to spring from the root, it is called a *scape*; this is seen in the Primrose.

165. The general position of the inflorescence is axillary to a leaf, but to this there are exceptions.

166. On looking at a form of inflorescence, one of two things will be observable; either that the flowers are arranged upon a lengthened axis, which is continued right through the inflorescence from its base to its summit, or that they are placed upon a depressed or more or less flattened one. The first or extended axis may be seen in the Foxglove, the other or depressed one

in the Dandelion. This latter kind of axis receives the name of *receptacle*.

167. The best analysis that has been given of the various modes of inflorescence, is that by Dr. Lindley, and of which we shall here avail ourselves.

168. The different forms of inflorescence may be divided into two great divisions; first, those having the flowers *sessile*, and, secondly, those having them *stalked*.

169. Those of the first division, or which have sessile flowers, can be now reduced into two secondary classes; the one comprehending sessile flowers arranged upon an *extended* axis, the other sessile flowers seated upon a *depressed* axis; there being two kinds of the extended axis, the *deciduous*, and the *persistent*. As an example of an inflorescence in which the flowers are sessile and arranged upon an extended persistent axis, we may take Wheat; as one in which the extended axis is deciduous, the catkin of the Hazel-nut; and as one in which the sessile flowers are seated upon a depressed axis, the Dandelion.

170. Those of the second division, or which have stalked flowers, are to be reduced in a like manner as regards their *axis*, namely:—into stalked flowers upon an extended axis—stalked flowers upon a depressed axis. The former is then to be subdivided into two orders; one in which the stalks are *simple*, the other in which they are branched or *compound*. As an example of an inflorescence in which the flowers are stalked and arranged upon an extended axis, the stalks being simple, we may take the Foxglove; the stalks being compound, the Meadow-Fescue-grass; and as one in which the stalked flowers are upon a depressed axis, the common Hemlock.

171. The further analysis of the various forms of Inflorescence will be better explained by the following table and figures, a more detailed account of each form being given afterwards, as they are of considerable importance in practical Botany.

Flowers sessile (a)	Axis extended (c)	Persistent.		*Spadix* (e) *Spike* (f)
		Deciduous.		*Amentum* (g)
	Axis depressed (d)—*Capitulum* (h)			
Flowers stalked (b)	Axis extended (i)	Stalks simple (l)	Of equal length.	*Raceme* (n)
			Lowermost longest.	*Corymb* (o)
		Stalks divided (m)	Inflorescence extended and centripetal.	*Panicle* (p)
			Inflorescence depressed and centrifugal.	*Cyme* (q)
	Axis depressed (k)	*Umbel* (r)		

Fig. 27.

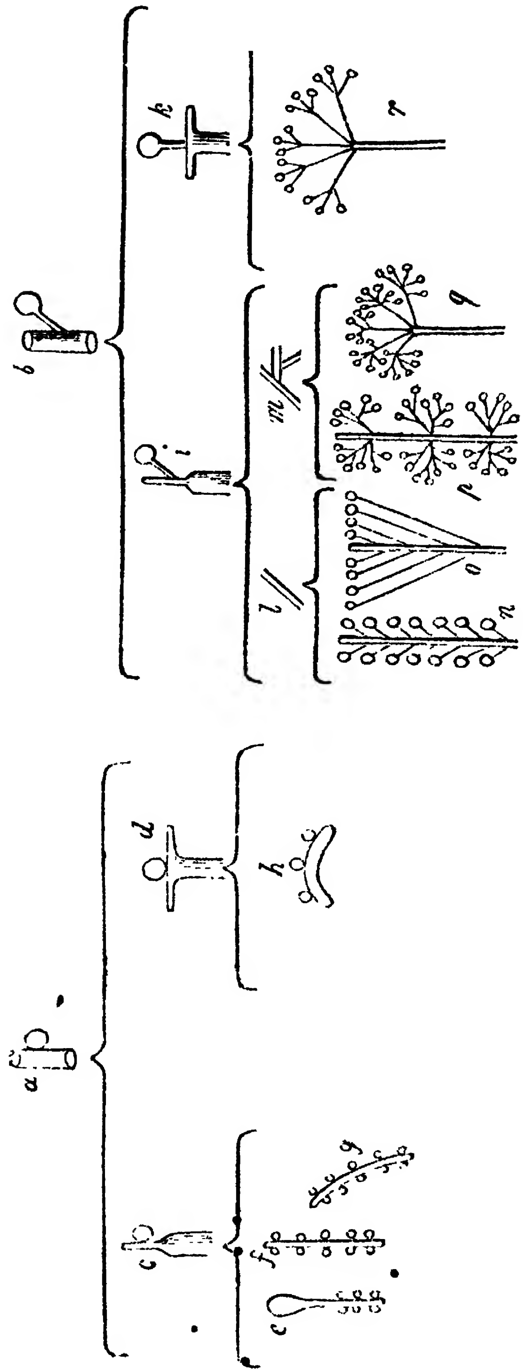
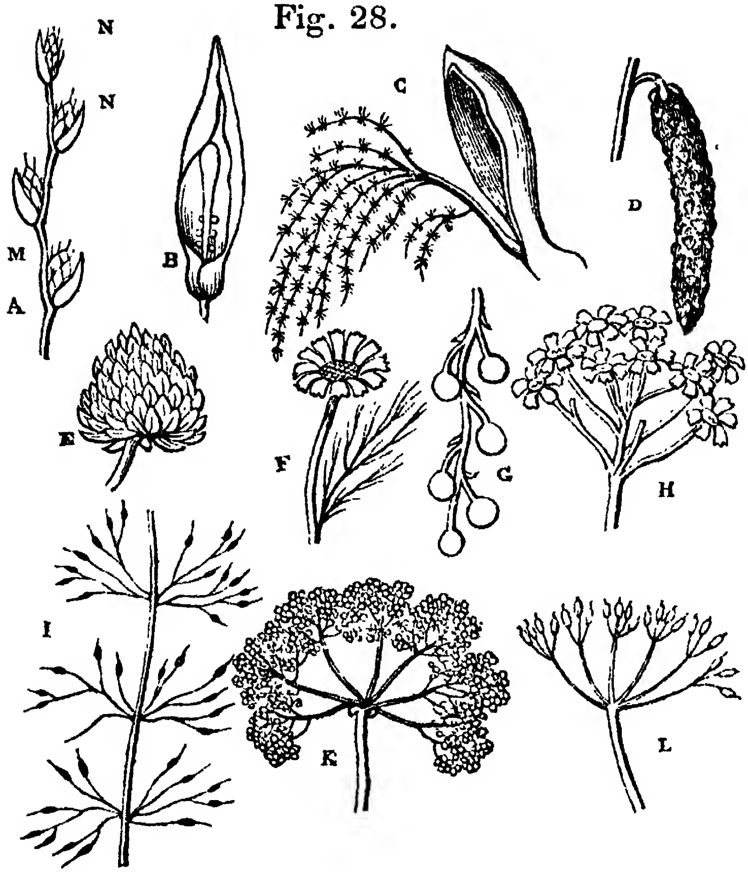


Fig. 28.



172. The *spike* (A) is essentially characterized by the flowers being *sessile* upon the extended axis. Examples may be seen in many of the Grasses, &c. It generally grows erect, and the expansion of its flowers is markedly progressive, the lower ones often fading before the upper ones have opened.

173. The *spadix* (B) has a fleshy axis sometimes extending beyond the *sessile* flowers which are enclosed in that form of envelope called a *spatha;* it sometimes becomes branched as in some Palms (C). It occurs only in monocotyledonous plants; it is seen in *Arum maculatum.*

174. The *amentum* (D) is characterized by the flowers of the extended axis being destitute of true calyx and corolla, and the axis and its appendages dropping from the plant together in a mass. It is seen in the Hazel-nut.

175. The *capitulum* (E) has sessile flowers on a depressed axis, as in Clover, which axis and flowers are sometimes enclosed with a general involucre, as in Chamomile, when it is called an anthodium (F), (the compound flower of Linnæus.) The outer or large *florets* of an anthodium being termed the florets of the ring, and the inner or more compact ones, the florets of the disk.

176. The *raceme* (G) has stalked flowers on an extended axis, the stalks being simple and all of the same length as in the Currant.

177. The *corymb* (H) differs from the raceme only in having the stalks of the lower flowers longer than those of the upper ones, so as to bring them sometimes to the same level. It is seen in the Millfoil.

178. The *panicle* (I) has its flower stalks branched and divided, and the axis of inflorescence considerably extended; it may be seen in the Grasses. The *thyrsoid* panicle is seen in the Lilac where the middle branches are the longest, and the panicle not lax.

179. The *cyme* (K) has its flower stalks divided, the primary stalks springing from a depressed centre, but the divisions or pedicels from an extended axis. It is seen in the Elder.

180. The *umbel* (L) has both its primary and secondary divisions rising from depressed centres; when only primary ones are present, it is called a *simple* umbel; when secondary exist as well, a *compound* one, and the whole the *general* umbel. It may be seen in the Hemlock.

181. The above-mentioned forms of inflorescence are those which are generally met with, the others being merely compound states, or so little modified that their type may be easily distinguished.

182. To the extended axis of the inflorescence of *Grasses* (M), the term *rachis* is applied; and to their little spikes (N N) of flowers, *locustæ*; and to the mode of axillary inflorescence seen in the dead nettle and similar plants, the term *verticillus,* or whorl, is given, but the form of inflorescence is essentially *cymoid.*

183. The flower, when existing in the state of a bud, is termed *alabastrus,* and the manner in which it is

folded when in this state, is called its form of *æstivation*, which may be plaited, as in Convolvulaceæ, *valvate*, as in Umbelliferæ, &c., &c.

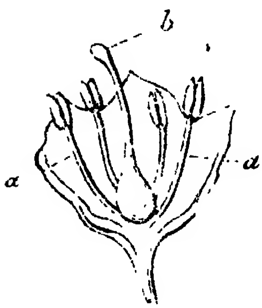
184. The period or time of the opening of the petals from the state of alabastrus, is termed the *anthesis*.

185. The structure of the calyx and corolla is much the same as that of the leaf, that of the calyx being less modified, however, than that of the corolla, and having much fibrous tissue; the stomatæ are small and few, as are the spiral vessels.

Generative Structures.

186. Within the floral coverings are contained these organs, which consist of the outer ones or male organs, called the *stamens* (*a*), and the inner or female one called the *pistil* (*b*).

Fig. 29.

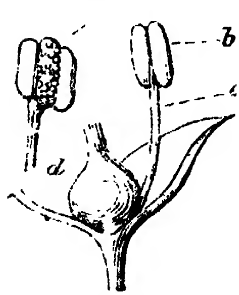


187. Both stamens and pistils do not always exist together within the same individual floral envelopes, but when they do the flower is said to be *hermaphrodite*, as at (fig. 29.)

188. When the stamens and pistils exist in separate flowers on the same plant, the flowers are said to be *monœcious*, as in the Castor-oil plant; when they are placed on different plants, that is, male flowers on one individual, and female ones on another, they are called *diœcious*, as may be seen in the Willows.

189. The stamen may be said to consist of three parts; the *filament* (*a*), the *anther* (*b*), and the *pollen* (*c*), the last two of which are essential to the formation of a male organ, the first is not; this may be wanting, the anther then being *sessile*.

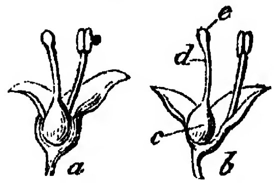
Fig. 30.



190. The *filament* (*a*), is a more or less slender elongated body bearing at its extremity the anther, always having its origin between the base of the ovarium (*d*), and inner surface of the corolla, or innermost floral covering.

191. Sometimes a degree of adhesion exists between the body of the ovarium and the base of the filament, so that the stamen seems to arise *above* the ovarium itself, as at (*a*), the stamens are then said to be *epigynous*; sometimes the filament adheres to the inner surface of the calyx or corolla, as at (*b*), it is then *perigynous*; but when it arises free at once from its true origin, as at (fig. 30), it is called *hypogynous*.

Fig. 31.



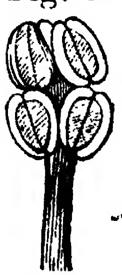
192. The general form of the filament is cylindrical, though it may be thicker at its extremity than its origin, or divided like a fork, or even foliaceous, &c.

193. When there are more stamens than one within a flower, the filaments of them are generally separate from each other, but they often become connected more or less together; and when they are united into one bundle or continuous tube, as at (*a*), they are called *monadelphous*; when into two bundles, as at (*b*), *diadelphous*; and when into more than two, *polyadelphous*.

Fig 32.

194. In some cases the filaments become all consolidated together, and form a solid body called a *columna*, which bears the crown of anthers at the top.

Fig. 33.



195. At the extremity of the filament is placed one of the essential parts of the male organ, the *anther*, (*b*, fig. 30.)

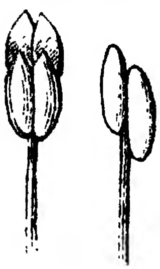
196. When we cut across the *fully formed* anther, in the generality of cases we see it formed of two cells or compartments of greater or less magnitude, filled with pollen; very few plants showing a one-celled anther.

197. If the anther had been examined at a much earlier period, we should, in all probability, have found it composed of four cells, the relative position of them varying very much according to the species which we were examining.

198. These four-celled anthers, as the plant increases in age, either by tearing away of their partitions, or else by a complete dissolution of them, become converted into two or one-celled anthers.

199. So universally does the fact seem to hold that the four-celled young anther should pass into a two-celled one, that it is probable in many of those cases in which the anther consists of four cells in the adult and ripe state, it is in consequence of two filaments being massed into one, and so bearing two two-celled anthers upon it ; this seems to be shown by Zannichellia, and likewise by the curious Diplanthera of Du Petit Thouars, in which there are two bilocular anthers seated upon the same filament, but at unequal heights.

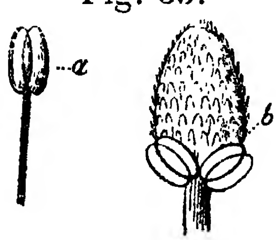
Fig. 34.



200. Micheli has stated that there exist three-celled anthers, but it is most probable, as Steinheil has suggested, that here one cell has been wanting from abortion.

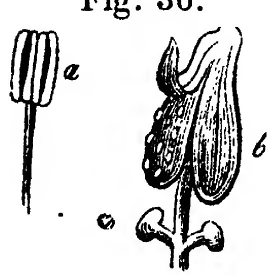
201. The cells of the anthers are united to each other by a prolongation of the tissue of the filament, called the *connectivum* (*a*); sometimes this connectivum is known to be prolonged beyond the apex of the anthers, as at (*b*), etc.

Fig. 35.



202. The place at which the anther opens to emit its contents is called its point or line of *dehiscence*. The dehiscence in most cases takes place by means of an opening running from the base to the apex of each cell, this is called longitudinal dehiscence (*a*) ; sometimes it dehisces by *pores*, at others by *valves*, as at (*b*), in an example from Dr. Lindley.

Fig. 36.

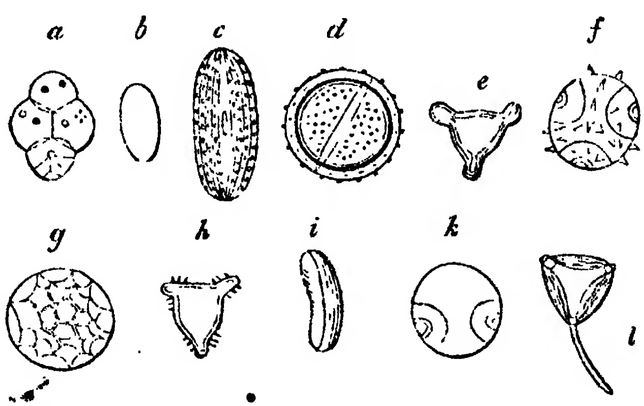


203. Within the cells of the anther is contained the *pollen*, which consists of a great number of granules or pulvinuli,

afterwards brought into contact with the extremity of the female organ.

204. The origin of these grains of pollen seems to be the following: as soon as the walls of some of the cellules of the tissue of the anther have become converted into a sort of consistent mucus, there form within it a great number of little grains which serve as nuclei, around which the mucus hardens to a membrane, becoming in a little time developed in the form of a spherical cell, within which remains the nucleus. Between the nucleus and the spherical cell is still contained some mucus; other nuclei are formed within this, around which the mucus hardens to a membrane, as before; each of these nuclei is the origin of four grains of pollen caused by the nucleus separating into four distinct cells: the rest of the structure we have spoken of becoming absorbed and destroyed by pressure as the pollen grains increase in size.

Fig. 37.



205. Generally all the pollen grains are free or distinct from each other, though they appear, in some cases, connected by a great number of thready fibres, or cobwebby-looking matter.

206. There are plants, however, as the Orchideæ, in which the grains of pollen are united together by fours, as at (fig. 37, *a*); this arises, according to the

views of some, from the membranous cells we before spoke of as enveloping the nuclei, not being absorbed or destroyed; and, according to others, from an actual growing together of the four grains, which is much stronger in some genera than it is in others; these smaller pollen masses are connected to each other by a peculiar yellowish sticky matter somewhat resembling birdlime.

207. The forms of the individual grains of pollen are very various; perhaps the most common is the ellipsoidal (*b*), a very complete example of which is seen at (*c*), the pollen of Ruellia barlerioides. The spherical is seen in the Coniferæ (*d*), and a lenticular with projecting corners at (*e*). Other forms are seen in the same figure.

208. The grains of pollen of most plants have their coats composed of two membranes; the outer one is called the *extine*, aud the innermost the *intine*. According to some, in Coniferæ and in few other plants, there are three coats, and in Œnothera and Clarkia, often four. Meyen denies, or rather doubts, this last statement of Fritzche, from his own observations on the same plants.

209. The intimate structure of these coats cannot be said to be determined, many regarding them as cellular tissue, others as homogeneous membrane: the latter opinion appears, I think, the more probable.

210. The external surface of pollen is very variously marked in different species, as is seen in (fig. 37); in most grains in which the development is longitudinal, as at (*i*), there is a mark or furrow extending along them from end to end, and in others, as at (*k*), there are circular spots or marks upon their surface. These, according to some, are openings of the external coat; according to others, mere thinnings of it.

211. The matter contained within these coats, or otherwise the contents of the grains of pollen, is called the *fovilla*. It consists of a more or less thick and transparent mucus in which two distinct kinds of bodies are seen endowed with motion; the larger of these

bodies is not only, in some cases, endowed with motion which might be denominated molecular, or that might arise from currents in the fluid in which they are contained; but have, according to Meyen and others, a distinct worm-like or writhing motion, folding one portion upon another of themselves. These are by some thought to be *spermatic animalculæ;* others regard them in the same light as they do the smaller bodies, namely, that they are composed of fecular or gummy and sometimes oily matter.

212. Upon contact of the grains of pollen with the female organ, the *intine* protrudes itself in the form of a membranous tube through which the fovilla passes to its destined situation. This *pollen tube* (*l*), will be spoken of under Physiology.

213. In regard to the minute structure of the parts of the male organ, we may remark, that the filament is composed of a bundle of very fine fibrous and vascular tissue, enveloped in a covering of cellular or parenchymatous structure. The anther is almost destitute of true vascular tissue, but possesses a peculiar modification of fibre which we spoke of before. According to Meyen, this fibre in the *endothecium,* (or lining portion of the anther), does not exist during the first period of the evolution of the organ, but is formed afterwards, and it is supposed to be instrumental in effecting its dehiscence. For further information upon all points connected with this subject, the reader, if a German scholar, is referred to the third volume of Meyen's Pflanzen Physiologie.

214. In the centre of the stamens is placed the pistil, the female organ of the flowering plants, and the organ forming the conclusion of the plant's axis.

215. The pistil ordinarily consists of three portions, (see fig. 31), where (*c*) is the ovarium, (*d*) the style, and (*e*) the stigma.

216. The *style* is not essential; sometimes the stigma being seated at once upon the top of the ovarium, which is then sessile, as in the Poppy.

217. When present, it is only an elongation of the ovarium, and is mostly of a cylindrical and filiform shape, varying in length according to circumstances, and its external surface is generally smooth; it arises at once from the top of the ovarium: though sometimes it appears to have its origin more or less on the side, or even towards the base of this body; this is more apparent than real, for it is caused by the ovarium being irregularly and obliquely developed.

218. Often the *style* is simple, but several may become massed, or grow together, so as to form a continuous body; in other cases, when there is a plurality of pistils, the styles of them remain distinct.

219. The *stigma* is but a terminal expansion of the style, varying very much indeed in form and appearance: it is characterized generally by being of a swelled and dilated form, and covered with papillæ of greater or less magnitude, the surface being destitute of true epidermis.

220. The most important part of the pistil is the ovarium, a knowledge of which is most essential and necessary.

221. The true origin of this body is always, of course, *superior* to the floral envelopes and stamens; but as in some cases more or less adhesion exists between the ovarium and these structures, so as to make it *appear* to arise below them, the ovarium is then called *inferior*, as at (*a* 31.)

222. In some cases the axis of the plant, after having given off the floral envelopes and stamens, is prolonged beyond them for some little distance before the female organ is evolved, as in the Passion-flower. This prolongation of the axis, in such cases, is termed a Gynaphore.

Fig. 38.

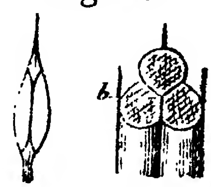
223. The primary state of evolution of the female organ or pistil, is leaflike and foliaceous, and to this leaflike structure, out of which the pistil is formed, the term of carpel, or carpellary leaf, is applied.

224. In those cases in which the pistil and ovarium are formed out of one carpellary leaf, it is called *simple:* when out of more than one, as is most frequently the case, *compound.*

225. When the several carpels forming a compound pistil remain distinct from each other, they are termed *apocarpous;* when united, *syncarpous.*

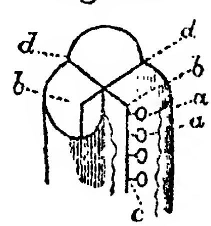
226. The *ovarium* itself is formed by the folding inwards of the carpellary leaf (fig. 39, *a*); and when the ovarium is composed of a plurality of carpels, they are arranged round a common centre, their folded edges meeting, as it were, in its imaginary axis, as at (*b*).

Fig. 39.



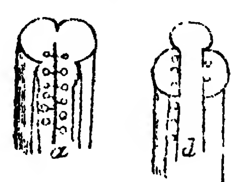
227. Within each ovarium is contained the *ovule,* or ovules (*a a*), which become, after impregnation, the seeds. These ovules arise from a body (*b*), which juts out into the cavity of the ovarium, called the *placenta,* to which they are attached very often by a *funiculus* or cord (*c*).

Fig. 40.



228. Very often the placenta has its origin from the *folded edges* of the carpellary leaf (as at 40), and it is then called *central;* sometimes it arises from the axis of the plant itself, as in the Primroses, and remains free in the cavity of the ovarium, the carpellary leaves of which are not individually folded up as before; it is then called *free central* (*a* 41); and at other times the placenta arises from the walls of the imperfectly folded carpellary leaves (*d* 41), it is then *parietal.* Central and parietal placentæ with their ovules are evolved by the carpellary leaf, whilst most free central placentæ with their ovules come directly from the axis.

Fig. 41.



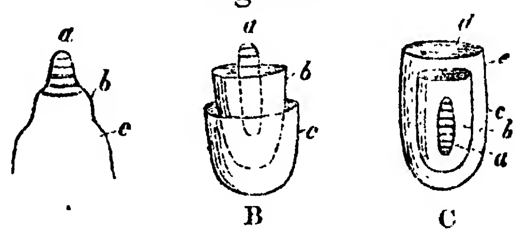
229. A central placenta is always alternate with its own *dissepiments,* and opposite to those of another

carpellary leaf; the *dissepiments* being the partitions of an ovarium formed by the united sides of the carpellary leaves (*d d* fig. 40): so it follows that a *simple* ovarium has no dissepiments.

230. The *ovule* is a minute body attached to the placenta, and contained within the cavity of the ovarium, afterwards becoming the seed of the plant, whilst the ovarium itself becomes the fruit vessel.

231. In the fully devèloped state the ovule may be said to consist of two parts—its *coats*, and the *nucleus* contained within them.

Fig. 42.



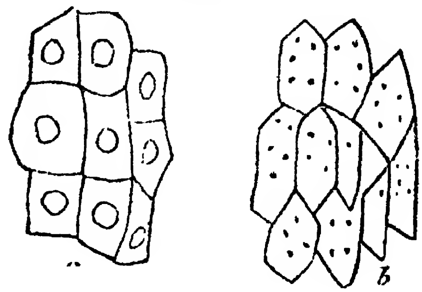
232. At first the *nucleus* exists alone as a very minute conical protuberance (*a* A); soon a swelling at the base of it (*b* A) is seen to take place, which gradually enlarges and extends itself around the nucleus in the form of a covering (as at *b* B), but remains open at the top: whilst this has been going on, a second swelling (*c* A) has arisen, which extends itself in like manner all over the other one and the nucleus within it, (*c* C) remaining like the last open at its extremity. The nucleus has now formed its two coats; the outermost or last formed one (*c*) being called the *primine*, and the innermost and first formed (*b*) the *secondine;* the opening of the primine (*d c*) is termed the *exostome*, and that of the secondine (*e b*), *endostome*, and these exist from the very first period of the formation of the coats.

233. In by far the greater number of plants the ovule has two coats, though in some exogens it has but a single one, which is termed by Schleiden, *integumentum simplex*. In some few examples it has likewise been lately shown that the nucleus has no true coats at

all. The Miseltoe and Santalum are examples of such structure.

234. In the cells of the tissue of which the coats of the ovule are formed, often exist large globules or grains, as at (*a*); and when the period of fertilization approaches, a number of minute granules are developed within these, which latter seem to expand and lose their substance, whilst the minuter granules alone remain, as at (*b*).

Fig. 43.



235. The *nucleus* varies very much in form and appearance in relation to the other parts of the ovule, and it sometimes protrudes at an early period of its formation beyond the *foramen,* as the endostome and exostome, when spoken of collectively, are termed. The only points at present concerning the nucleus to be considered, are those relating to its position or direction, as under the function of generation the nucleus will be referred to again.

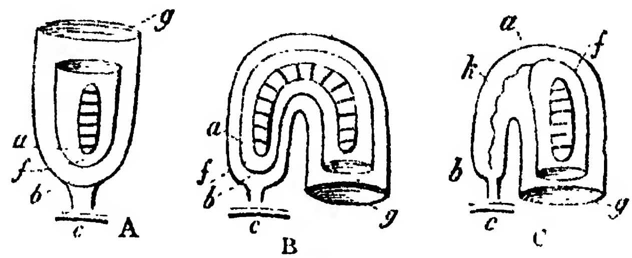
236. Between the coats of the ovule and the nucleus, there is a connection kept up by means of the vascular and cellular tissue, derived from the placenta in the form of a *funiculus* or cord.

237. The *funiculus* consists of spiral vessels and cellular tissue; this bundle pierces the primine, its *vascular* system spreading upon the secundine, whilst its cellular connects the base of the nucleus with that coat. The spot where this takes place is the true base of these bodies, and the ramifications of the spiral vessels upon the base of the secundine is termed the *chalaza.*

238. When the base of the nucleus and secundine (A *a,* fig. 44) is contiguous to the base of the primine (*b*), and these are close to the true base of the whole ovule, which is at the placenta (*c*), its axis being *rectilinear,* we have an *orthotropous* ovule, as in the Nettle (A).

239. When the base of the secundine and nucleus still keep, as in the former case, to the true base at the placenta, but the whole ovule is doubled down upon itself, its axis ceasing to be rectilinear, we have a *campulitropous* ovule (B), as in the Mustard.

Fig. 44.



240. When the base of the nucleus and secundine no longer keep with that of the primine or true placental one, but is turned quite away from it, the nucleus, etc., being, as it were, upside-down, we have an *anatropous* ovule (C), as in the Apple.

241. These are the essential differences in regard to the direction of the parts of the ovule, and we must remember that in the orthotropous ovule, the chalaza (*f*), is at the proper placental base, whilst the foramen is opposite or at the point of the nucleus farthest away from it (*g*): in the campulitropous ovule the chalaza is at the placental base, but the foramen is brought down to one side or level with it, whilst in the anatropous ovule the chalaza is *removed* from the placental base, and the foramen is brought down to it. In this example, in consequence of the removal of the base of the secundine and nucleus from that of the primine and placental one, a vascular cord (*k*), called the *raphe*, is sent up until it meets with the base, when it expands upon it as the *chalaza*.

241. We have now described the reproductive structures and their parts as they exist immediately previous to fertilization, and only have left certain modifications or transformations of portions of them to speak

of, which are brought about by the performance of that function, such as the changes of the ovarium and its contents into fruit and seed. Before doing so we may remark, that between the base of the ovarium and that of the stamens there is very often a thick or fleshy body called the *disk;* in the Umbelliferæ this disk spreads all over the body of the ovarium, and becomes firmly attached to the bottom of the styles, but the most common form of it is a thickened ring, or irregular lobed protuberances, upon which the ovarium appears to be seated. It has been regarded as stamens in a very rudimentary, undeveloped state.

Fruit.

242. The *fruit* is the ovarium, and its contents become perfected as a result of the action of fertilization or impregnation.

243. It consists of two portions, the *pericarp* or covering, and its contents, the *seed.*

244. The pericarp (fig. 45) is the ripened *ovarium,* and the seed the matured *ovule,* both of which structures in arriving at the state of which we are now speaking, undergo many modifications.

245. The *pericarp* consists of three portions; the *epicarp,* or outer coat, the *sarcocarp,* the second or fleshy coat, and the *endocarp,* the third and most internal coat. These are well seen in the *Nectarine,* in which the outer skin is the epicarp, the fleshy, juicy matter, the sarcocarp, and the stone containing the seed, the endocarp. In those cases in which the ovarium is called *inferior,* the epicarp is closely covered by the ripened *calyx,* as in the *Apple.* The modifications under which the whole *pericarp* or these portions of it appear, are very various, and are noticed in the different descriptions of *fruits* further on.

246. The fruit is said to be uni-bi-, or trilocular, etc., according to the number of its cells or compartments.

247. Although the ovarium may be two or three-celled, it does not always follow that in the ripened state of it, or fruit, it should still continue so, for by abortion, etc., a *three*-celled *ovarium* may become a *one*-celled *pericarp*, as in the Cocoa-nut.

248. When the fruit becomes ripe, the pericarp either opens spontaneously to allow of the exit of the seed, as in the *Bean*; or it remains closed, as in the *Apple*: in the former case it is said to be *dehiscent*, in the latter, *indehiscent*.

249. In *dehiscence*, of course, portions of the pericarp must separate from each other; such places of separation are termed *valves*.

250. In those pericarps formed from a single carpellary leaf, as that of the Bean, the valves separate from *sutures*; such is called *sutural dehiscence*.

251. The *dehiscence* is said to be *septicidal* when it takes place by a separation of the *dissepiments* from *each other*, as in a Rhododendron.

252. *Loculicidal*, when it takes place by the opening of the *back* of the *cells*, as in a Lily.

253. *Septifragal*, when it occurs from the *dissepiments* separating from the *valves*, as in a Convolvulus.

254. *Circumcissile*, or tranverse, when the separation takes place by the cells dividing tranversely or across, as in the common Pimpernel.

255. In a few cases the dehiscence is very irregular, the portions of the pericarp separating bearing no methodical relationship to the cells of the fruit; such is seen in the Snap-dragon and Bird's-foot Trefoil: the first dehisces by *rupturing*. the other by *solubility*; the one-celled pericarp of the latter dividing into distinct and separately closed portions.

256. The different appearances which the pericarp assumes as regards form and texture, give rise to the various kinds of fruits which are seen.

257. *Fruits* have been very variously classified by authors, but most of their systems are essentially unphilosophical, because the structure of the primal origin

of the fruit, the ovarium, is left out of view; and all such systems, however easy and simple they may appear as far as regards their immediate applicability, will be found to be based upon principles which will, instead of leading the observer to any true idea of structure, lead him to an indistinct and superficial notion of affairs. The classification of Dr. Lindley, however, is one based upon principles derived from an accurate investigation of the laws regulating the development of the fruit in its ovarial state.

258. According to which all fruits may be divided into four classes,—*simple, aggregate, compound,* and *collective.*

259. *Simple* fruits are those in which the ovaria are distinct from each other, formed out of a single carpellary leaf, and no more than one series of them produced a single flower, as in the Bean.

260. *Aggregate,* in which the ovaria are simple like the last, but more than one series of them is developed by each flower, as in the Strawberry.

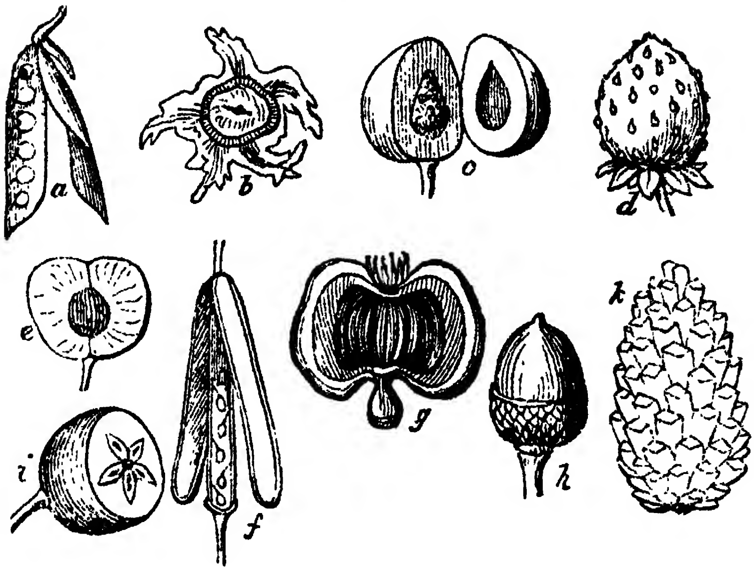
261. *Compound,* in which the *ovaria* are *compound,* the carpellary leaves of them becoming united to each other, as in the Apple.

262. *Collective* in which the ovaria of *many* flowers become massed together, the fruit deriving its characters from the incrassated floral coverings, as in the Fir-cone.

263. Under these heads we shall place the different forms of fruit *most commonly met with.*

Simple Fruits.	Many seeded.		Legumen	The fruit of the Bean.
	One or two seeded.		Utriculus	Beet.
			Nux	Borage.
			Drupa	Nectarine.
Aggregate Fruits.	Ovaria above the Calyx.		Œterio	Strawberry.
	Within it.		Cynarrhodum.	Rose.
Compound Fruits.	Ovaria superior.	Pericarp dry.	Caryopsis	Wheat.
			Samara	Elm.
			Siliqua	Charlock
			Silicula	Shepherd's purse
			Capsula	Poppy.
		Fleshy.	Nuculanium	Grape.
			Hesperidium	Orange.
	Inferior.	Dry.	Glans	Acorn.
			Akenium	Chamomile
			Polakenium	Hemlock.
		Fleshy.	Pomum	Apple.
			Pepo	Melon.
			Bacca	Currant.
Collective Fruits.			Syconus	Fig.
			Strobilus	Fir.
			Sorosis	Mulberry.

Fig. 45.



264. *Simple fruits.* The *legume*, or pod (*a*), is one-celled, or many-seeded, the seeds being borne on a ventral suture, the *dehiscence* being sutural by two valves. (The Pea.) The *follicular* form of it (as in the Peony), dehisces by one valve, and the *lomentaceous* (as in the Birds-foot Trefoil), by *solubility*.

265. The *utricle* (*b*) is membranous, one-celled, and one or two-seeded, and often dehiscing by a transverse incision. (Beet-root.)

266. The *nut* is hard, dry, and indehiscent, one-celled and one-seeded, the pericarp not adhering to the seed itself, and superior. (Borage.)

267. The *drupe* (*c*) is soft and fleshy, with a stony endocarp, and indehiscent, one-celled, and one or two-seeded. (Nectarine and Cherry.)

268. *Aggregate fruits.* The *œterio* (*d*) has its ovaria distinct from each other, the pericarps being indehiscent, and placed upon an enlarged receptacle, which is sometimes fleshy, as in the fruit of the Strawberry; or dry, as in a Butter-cup. The minute pericarpia are nuts.

269. The *cynarrhodum* has the hardened indehiscent pericarpia enclosed within the fleshy tube of a calyx, as in the Rose.

270. *Compound Fruits. Superior.* The *caryopsis* is dry and indehiscent, and the endocarp adheres to the integuments of the seed, there being only one seed and one cell. (Grasses.)

271. The *samara* (*e*) is dry and indehiscent, having two or more cells few-seeded, and expansions or wing-like appendages. (Elm.)

272. The *siliqua* (*f*) is one or two-celled and many-seeded, dehiscing by two valves from a *spurious* dissepiment, and the fruit is longer than it is broad, as in the Wall-flower; the siliculose form of it, or *silicula*, is broader than it is long, as in Shepherd's-purse.

273. The *capsule* (*g*) is dry and dehiscent by valves variously placed, mostly at the top of the pericarp, one or many-celled, and many-seeded. (Fig: (*g*) is a *section* of the capsule of the Poppy showing the parietal placentæ.)

274. The *nuculanium* is completely pulpy and indehiscent, many-celled and seeded. (The Grape.)

275. The *hesperidium* is indehiscent, many-celled, and few-seeded, the cells containing the seeds being filled with juicy pulp, and outer coats of the pericarp passing one into the other, forming a removeable rind. (Orange.)

276. *Inferior.* The *gland* (*h*) is hard and indehiscent, one-celled, and few-seeded, and enclosed either wholly or partially within a cupula. (The Oak and Chesnut.)

277. The *achenium* is dry and indehiscent, the pericarp not adhering to the integuments of the seed, and is one-celled and one-seeded. (Chamomile.)

278. The *polakenium* is dry and indehiscent, many-celled, one-seeded, the cells separating from a common axis. (Hemlock.)

279. The *pome* (*i*) is fleshy and indehiscent, many-

celled, few-seeded; the outer coats of the pericarp are united with the calyx, and the inner one is horny. (Apple.)

280. The *pepo* is indehiscent and fleshy, one-celled, and many-seeded, the seeds having a parietal placentation, and imbedded in pulp. (Cucumber.)

281. The *berry* is pulpy and indehiscent, many-celled and many-seeded, the seeds being loosened from their placenta as the fruit becomes ripe. (Gooseberry.)

282. *Collective Fruit.* The term *syconus* is applied to a fruit formed of a depressed fleshy axis, bearing separate flowers, whose pericarpia are dry. The axis is sometimes in the form of a hollow receptacle. (The Fig.)

283. The *strobilus* or cone (*k*), presents a form of structure very different indeed from the fruit of most other plants, and its true signification must be said to be yet undecided. According to Brown, the scales of a cone are *bracteæ*, within which and laying upon the face of them are the open and scale-like ovaria, upon which are a pair of naked ovules; whilst, according to Schleiden, the scales are not bracteæ, but actual carpellary leaves, whilst the expansions on their internal faces are enlarged placenta. Whatever view is taken of them, the student will see here an example of what are termed naked seeds, but must remember that what were thought to be so by Linnæus, or at least so called by him, are not naked seeds at all, but seeds whose pericarpia become contracted closely upon them, as in Labiatæ, &c., and which are distinctly enough endowed with a fruit-like covering, though in the Coniferæ they are truly destitute of it.

284. The *sorosis* is fleshy, formed by the union of both ovaria and floral coverings into a single mass. (Mulberry.)

285. Having described the ripened and matured ovarium under the form of pericarp, we have now to speak of the perfected ovule under the form of seed.

286. The base of a seed is that part by which it is attached to the placenta, and is called the *hilum*; this

is seen at (*a*) the mark on the face of a Kidney-bean; in most cases, it is of a darker colour than the rest of the seed, as in the common Broad-bean and Horse-chesnut. In small seeds it is so minute as to be scarcely discernible. The *apex* of the seed is not always opposite the base or hilum, but is sometimes even brought down on a level with it; it may often be determined by observing the point at which certain radiating lines, seen upon the surface of many seeds, and having their base at the hilum, meet together; or in other cases by the mark of the chalaza.

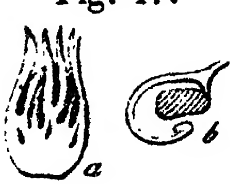
Fig. 46.

287. The seed may be divided into three portions: the *coats, albumen,* and *embryo.*

288. The coats or integuments of the seed, spoken of collectively, are termed the *testa,* which in many cases can be separated into three distinct layers: the outer or *true testa,* the second or *sarcodermis,* and the third or *endopleura.* Sometimes, however, not more than one distinct layer can be demonstrated, whilst it is stated that in some examples five may be seen. The outer integument is very various in nature and appearance, from being fleshy to bony, and from smooth to hairy, and often presents in its minute structure a peculiar modification of fibre, or fibro-cellular tissue.

289. Besides these proper seminal integuments, there often exists another more or less partial one denominated the *arillus;* this is seen in the form of a membranous expansion of greater or less size, and variety of figure, arising from the placenta along with the funiculus, and extending itself over the body of the seed; it having been looked upon as characteristic of this covering, that it is never developed till after the fertilization of the ovule, it has been considered quite distinct from the other coverings of the nucleus, and not to be considered in relationship with them. But, as a German physiologist

Fig. 47.



has observed, it does not seem reasonable to separate the arillus from the coverings of the nucleus, as something quite foreign to them, for we know that in Epipactis the primine does not extend over the secondine till *after* impregnation; whilst in Orchis, (and probably in all the rest of the Orchideæ), the primine is completely developed *before* impregnation; and therefore if the mere *after*-development constitutes an arillus, the primine of Epipactis must be evidently such. Its more evident origin from the *placenta* itself, than from the base of the nucleus, like that of the true ovular coats, is another mark which may be put forward to demonstrate its character. "But," says Meyen, "we find in other cases at the *funiculus* of the unimpregnated ovule, the first condition of the appendage we are here speaking of." A good example of the *arillus* is seen in the Nutmeg, (*a* fig. 47) enveloping the seed in the form of a notched and divided covering, forming the Mace of commerce; at (*b*), is seen the arillus of a Vetch.

290. In some seeds whose ovulum was anatropous, the *chalaza* is seen at the apex of it in the form of ramifying vessels, as in that of the Orange; but in others of the same kind the *raphe* is more observable, extending as a line or mark from the hilum along the *face* of the seed to where the chalaza has its situation. Close to, or around the hilum of the seeds of some plants, are little protuberances denominated *carunculæ*.

291. Within the testa or seed coverings are contained the *albumen* (*a*), and *embryo* (*b*); the first is often absent, the seed being then termed *exalbuminous*.

Fig. 48.

292. The *albumen* in ripe seeds is mostly of a white or yellowish colour, though in the Miseltoe it is green, and in Pittospermum it is said to be red: its consistence is very various; mealy, hard, or more or less leathery states of it are seen. Its size and quantity in relation to that of the embryo

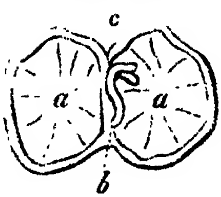
which is embedded in it, is very different, being scarcely discernible in some cases, whilst in others, as in the Cocoa-nut, (the white eatable substance) it is very considerable. The albumen of the Nutmeg is said to be *ruminated;* the appearance it presents arising from its being traversed by layers of cellular tissue, differing from the rest of the solid albumen. The albumen is generally of a farinaceous, saccharine or oily nature, though sometimes even bony.

293. The most essential part of the seed, the *embryo,* is, as its name implies, the germ of another being, and only waiting for the conditions necessary to call into action its yet slumbering vitality ere it springs in a new and perfect plant.

294. A seed generally contains only one embryo, though sometimes, as in the Pine tribe, several are developed within the same testa.

295. The embryo may be said to consist of three parts: the *cotyledons* (*a a*), the *radicle* (*b*), and the *plumula* (*c*). (These may be easily observed on dividing a broad Bean.)

Fig. 49.



296. The seeds of a great many plants, as those having *exogenous* stems, have, as a general rule, always *two cotyledons,* as at (fig. 49), and such plants are termed *dicotyledonous,* as the Oak or Bramble.

297. The seeds of plants having *endogenous* stems, have, as a general rule, only *one cotyledon,* and are termed *monocotyledonous,* as the Lily or Grass.

298. Whilst other plants, as Ferns, etc., have no true cotyledonary body which holds a relationship to the other parts of the embryo, similar to the other two, these are called *acotyledonous.*

299. Though these may be stated to be the general rules, several exceptions exist to what we have stated.

300. For instance, in otherwise Dicotyledonous plants (that is, plants presenting other circumstances known to accompany the existence of two cotyledonary bodies

in the Embryo), there may be present more cotyledons than two, as in some Cruciferæ, etc.; the two may be joined together and inseparable, as in Ebena Cretica; one may be very large, and the other in a rudimentary state, as in Sorocea; and *often* in the Common Nettle, according to Meyen, and *always* in Chenopodium viride, etc. etc.; or there may be no cotyledons at all, as in Cyclamen.

301. In some Grasses, as Triticum, the rudimentary state of a second cotyledon is to be seen; and it has been asked by a writer, whether in *monocotyledons* generally a second cotyledonary body is not evolved contemporaneously with the other, but which by a diversion of powers from its further development to something else, remains hidden or behind? He himself answers it in the negative in regard to the greater number of Endogenous plants.

302. On separating the cotyledons of the Bean, (fig. 49), we observe a little body which we can divide, as it were, into two parts; a somewhat curved tapering body (*b*), the *radicle*, and a more expanded flattened one at the end of it (*c*), the *plumula*.

303. The radicle (*b*), always points towards what is termed the *micropyle*, so that without opening a seed, if we can find the micropyle, we know the position of the radicle of the embryo.

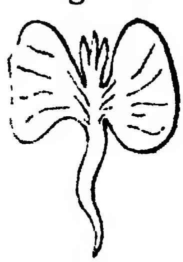
304. This *micropyle* exists as a minute opening on the testa of the seed, and has its origin in most cases in the altered condition of the *foramen* of the ovule; so that again if we can find the foramen in the ovule, we know to where the radicle of its embryo will point.

305. If we examined such an embryo in the young state, after it has reached its second stage of development, we should find the embryo existing in the form of a somewhat globular body just commencing to alter its shape; it extends itself somewhat in length so as to form an axis, the lower end of which points towards the micropyle, and the upper towards the chalaza, and it now begins to form the cotyledons and radicle; the co-

tyledons in some cases (as in Capsella, according to Meyen), being evolved before the radicle; whilst in others, as in Draba, they seem to be evolved at the same time. With the development of the cotyledons at the upper end of the axis of the Embryo, the axis is extended further in the form of what is termed radicle towards the micropyle, whilst at its upper extremity at the base of the two cotyledons, is developed the first bud or plumula, which is more or less evident in different seeds before germination.

306. Suppose the proper development of these parts to have ensued, and the seed in which they are contained placed in moist earth, etc., the extended axis of the Embryo below the cotyledons elongates a little immediately beneath them, so that the cotyledons are removed as it were from the other end of the radicular axis, which is now beyond or out of them: either nearly the whole of the radicular axis, as in the common Bean, dives below the ground to form the root, or else the end of it only, as in some Cruciferæ, the upper part of it rising to form the stem: the cotyledons are then either elevated above the ground, and unfold as leafy expansions, or else remain below, and after serving their purpose wither away; and the *plumula* elongates and developes itself upwards towards the light, as the first bud, and adding to, or forming the young stem.

Fig. 50.



307. From what is stated, it must be remembered that originally the cotyledons are formed *out of the axis of the embryo,* and not the *radicular and plumular axis* from them; and that the extended axis of the embryo below the cotyledons, or *radicle* as it is called, may in some cases produce both root and stem, whilst in others nearly the whole becomes root; but that as far as regards minute structure, it is doubtful whether a difference exists in the embryo state between those parts of the radicular extension of the axis serving these two

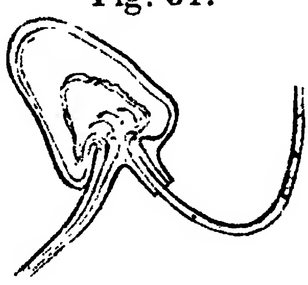
different purposes, although Bernhardi has stated that in many cases the limits between the two can be pretty well made out, and to which the term *collum* has been applied.

308. Such as we have described are the general rules respecting the embryo and its relations, &c. in a Dicotyledonous plant, but in Monocotyledons they are somewhat different.

309. When we examine the embryo of the latter class, in the greater number of cases we find it a solid, uniform, somewhat cylindrical body, in which, when divided, no distinct radicle or plumula can be seen, they being incorporated with the one cotyledonary substance; in some, however, like those of Aroideæ and Gramineæ, they are more distinct, but the *whole* embryo in these two cases is somewhat modified.

310. When such an embryo is placed under the conditions of germination, the lower end of it elongates and opens, emitting the radicles, which have their origin from the *internal substance* of the minute radicular extension of the embryo, and not, as in the other case, by an immediate extension or lengthening of this axis, so that here they are enclosed at their origin by a sheath formed out of the structure through which they have to pass; whilst in a Dicotyledonous embryo, the radicle is naked. In consequence of these facts Monocotyledonous plants have been termed *endorrhizal*, having the radicle in a sheath, and Dicotyledonæ, *exorrhizal*, the radicle being destitute of one.

Fig. 51.



311. There are other modifications, however, of the mode of protrusion of the radicle; and even in Dicotyledonous plants the radicle, as remarked by Decandolle, may be made *endorrhizal* by cutting off the extremity of the original radicular axis, so that the internal substance of it must give out new ones: but notwithstanding what

has been said against the division of plants into *endorrhizæ* and *exorrhizæ*, there can be no doubt of the normal mode of the formation and protrusion of the radicle as accompanying a mono, or dicotyledonous embryo.

312. In that class of plants called *acotyledonous*, the nature of the embryo is that germination does not ensue from two particular points of its structure, like the plumula or radicle, but may do so from any part of it: some of these plants, like the Ferns, however, present other forms of structure, which rather entitle them to go along with truly monocotyledonous plants, and therefore the position of these tribes in the more general divisions of systematology is at present doubtful: concerning these plants, we refer to the systematical portion of the work for an account of their more compound organs.

313. According to the position of the embryo in relation to its coverings and their parts, it receives different terms. It is said to be *antitropal* when the radicle lies at the extremity of the seed *farthest* from the hilum, as in the Nettle; *orthotropal*, when the radicle is at the end of the seed *next* the hilum, as in an Apple; *heterotropal*, when it lies crossways, as in the Cowslip; and *amphitropal*, when the two extremities are presented to the hilum, as in the Dyer's-weed. Besides these the cotyledons bear certain relations to the position of the radicle, especially observed in cruciferous plants; when they have their edges presented to the radicle, the term *cotyledons accumbent* is used; but when the back of them is to the radicle, *cotyledons incumbent*. But it has been shown by Kunth that these conditions vary according to the age of the plant, as in Erysimum, where they are at one time *accumbent*, and afterwards *incumbent*.

DIVISION II.

Morphology and Development of Forms.

1. It would be without the intention of this work to enter either into an historical account of the doctrines of Vegetable Metamorphosis, or Morphology, or into an inquiry concerning their foundation in nature itself: all that we can say is that, as *many* of the circumstances upon which these doctrines are founded, are at once evident and true—that, as the fundamental principles of vegetable organisation have in cases been more securely settled by a consideration of these circumstances,—and that, moreover, as some of the most eminent continental Botanists are regulating all the principles of vegetable structure upon Morphological theory, we have thought it right to devote a separate portion of the work to its consideration, however slight that must necessarily be. It must be owned, however, that the doctrines of Morphology have been carried too far, laying so much stress upon *analysing down. to preconceived types* that the true nature of the *existing synthesis* has been often misunderstood or disregarded; and of the certainty of this so satisfied is an eminent French writer, that he says the anther is no more a metamorphosed leaf, than the leaf is a metamorphosed anther.

2. What we are to understand by Vegetable Metamorphosis, or Morphology, is—"that every appendage of the axis is originally constructed of the same elements arranged upon a common plan, and varying in their manner of development, not on account of any original difference in structure, but on account of especial, local, and predisposing causes; of this the leaf is taken as a type, because it is the organ which is most usually the result of the development of those elements—is that to which other organs generally revert when from any accidental disturbing cause they do not sustain the appearance to which they were originally predisposed—and, moreover, is that in which we have the most complete type of organisation."——"We cannot say that an organ is a metamorphosed leaf, when in point of fact it has never been a leaf."—(Dr. Lindley.) Therefore when the term metamorphosis of leaf is made use of in the following paragraphs, the student can apply to it its intended signification.

3. Of the theories of the general principles of Morphology, there are several the results of the labours chiefly of the German Botanist; and from that of Von Martius we shall extract the few remarks that follow these observations, and say a few words at the close of them upon certain parts of structure, and the symmetrical development of form.

a. A plant grows upwards and downwards, and so complete are the differences between these modes of growth, that in their consequences are included formations of very different nature to each other.

b. The root, shut up in itself as it were, is that, truly simple and uniform in a plant, unchangeably continuing its direction below, and extending itself out by division, but being neither in the whole or individual parts an active formation.

c. The upward growth of a plant is the light and air system of the same, and is directly opposed to that of the root.

d. This growth takes place in the more highly organized plants directly in two portions, evidently apart from each other, in the continual changes of whose various relationships is seen the entire aërial life of a plant.

e. These different portions are the axis or stem, and the leaf.

f. The stem is the remaining original part of all the aërial formations, is opposed to the leaf as being its support, and constitutes the central system or axis; the leaf on the other hand appears as a peripheral divided portion, which may be looked upon as separated here and there from the stem, and may probably be regarded as a secondary and again divided axis, but which in its internal formation must be looked upon as unsymmetrical.

g. The axis increases both in length and breadth, and divides by degrees like the under growth; but there is a very great difference between the growth of the stem and that of the root, for the first developes itself in length at certain periods, whilst the root is less subject to such periodicity, and therefore increases at all times.

h. The leaf developes itself as it unfolds, and is not only an extension and growth in length, but also one in breadth, and this development equally deviates from the perpendicular direction of the axis.

i. In the upward growth appear three evident points, in the evolution of which its whole formative power and activity is represented: these are, nodus, leaf, and internodium.

j. When we look at the place of origin of a leaf, we observe a thickening of the axis, and a sort of intangling of the vessels into a knot or nodus, immediately beneath it; above a nodus the vessels again assume a regular and symmetrical course until they arrive at the situation of another nodus, and thus along the axis several internodii are seen one above the other: according to the disposition of the internodial axes with

each other, is that of the nodus with leaf, and leaf with leaf, the normal position of which latter is their alternating with each other in a spiral direction along the axis ; but becoming opposite or approximating by the confluence of the nodii.

k. In the progression of the leaf three kinds may be seen—the ensheathed leaf or coleophyllum, the petiolated one or steleophyllum, and that destitute of petiole but having the lamina or placophyllum.

l. The common and true leaves are especially destined through the means of the inspiration and expiration of aërial fluids to increase and better the condition of the juices ; but it becomes otherwise in respect to those metamorphoses which always accompany the production of the germ.

m. At the summit of all metamorphoses of the leaf exists a generative function, the pistillar leaf of the female part closing the morphological series ; but these generative leaves do not follow immediately upon the green ones, their types, but between them exists another series.

n. The change of the leaf up to the coloured and sexual one, is the ascending metamorphosis ; in the descending metamorphosis is shown the return of these to the green leaves again.

o. A metamorphosis of the leaf is seen where instead of the evolution of a leaf-bud or twig from its axilla, that of a blossom or flower takes place ; the change is into a bractea, but which is the same in function, and approaches very closely to its original type.

p. In the flower itself the axis almost vanishes as regards development in length, and the metamorphosed leaves instead of being placed individually above each other with evident internodial spaces, become approximated and confluent, although in some cases there are sufficient marks to show that it is apparent only, and that the real evolution and position of them is that of their type, the leaf.

q. The leaves entering into the formation of the calyx and corolla, must be looked upon as the results of two states of metamorphosis, and confluence of nodii; they are the peripheral parts of two portions of the upward growth immediately following each other, evincing the metamorphosis on the one hand by an evident contraction of axis, and on the other by a change both in form and colour of the typical leaf.

r. The calyx is composed of leaves representing, as it were, the state of coleophylla, and bearing a relationship to the succeeding more finely organized ones, somewhat similar to that borne by the scales of a leaf-bud to their contents.

s. At a higher state of morphological evolution, the leaf becomes coloured, though in the young bud it is mostly a lightish green; but in this corollaceous form of it the leaf is not complete in the development of all its portions, the lamina being evolved whilst the petiole remains behind as claw, though often very small: should the leaves be united as a continuous piece, the connected claws form the tube, and the laminæ the limb of the monopetalous corolla.

t. In the stamens is seen the next stage of metamorphosis of the leaf into generative organs, the petiole being the type of the filament, whilst the anther represents its lamina, within which is seen the evolution of the pollen.

u. The pistil or carpellary leaf, is the last and crowning point of the morphological series, and here the three progressional states of the leaf are fully developed though metamorphosed.

v. The coleophyllum' forms the ovarium, the petiole the style, and the lamina the stigma.

w. The carpellary leaf rests immediately upon the axis, and therefore the further extension of it is arrested, the axis taking part so far only in the evolution of the germ itself, as can ensue from the axis becoming connected and blended with the suture of the

carpellary leaf from which the germ may appear, and which is more especially observable in the syncarpous ovarium.

x. Should the edges of each metamorphosed leaf become united with each other, and with the extending substance of the axis in the midst of them, we have a multilocular ovarium; but should the edges of the individual leaf not be thus connected, but merely united to the edge of the leaf contiguous to them, we have the ovarium unilocular.

y. In the development of calyx and corolla, two series of formations are seen; and in the number of the pieces forming a whole of each series of a regular flower, a uniform system is maintained.

z. Three and Five are the presiding numbers; three ruling in Monocotyledonous, and five in Dicotyledonous plants.

a a. The calyx and corolla generally remain true to these numbers; that is, they show but seldom a multiplication or diminution of them in a single whorl.

b b. A manifold state in the staminal series is much more common, and the carpellary one, especially in Dicotyledons, is subject to considerable reductions.

4. Now it will have been seen that the leaf is regarded as the typical structure which rules the formation of most other appendages of the axis, and from the perfect development of which type up to its highest stage of metamorphosis, transitional states may be seen.

5. Not only, however, may these transitional stages of a leaf to the highest point of its ascending metamorphosis be traced, but likewise very often the passage of them back again, and even the change of the last state of modification back at once into its typical form, without passing through any intermediate modification.

☞ To illustrate this we may remark that the bracteæ very often scarcely differ at all from the leaf, being

green, foliaceous, or even producing buds like that itself; whilst in other cases they become coloured, less firm, and harsh in texture, so that no true limit can be placed between them and the next stage, the calyx, which in some cases resembles the bracteæ, whilst in others again the true leaves themselves. In the corolla a considerable change is generally seen not only in the formation, but in the colour of the appendage; sometimes the series may be traced down through corolla, calyx and bracteæ, to leaf, all three rising so gradually from their type that it is impossible to mark the commencement of either; at other times the petals have been known to be like the leaves themselves. At the next stage of the series of morphological development, the change into stamens is to be seen; sometimes the passage of the petals into these organs is evident, whilst in others, though but rarely so, their conversion into their type, the green leaf, has been known. At the last or concluding change the pistilla are evolved, and in many flowers the relationship these bear to the leaf is distinctly observed: their conversion into petals, foliaceous expansions analogous to the sepaloid pieces of the calyx, and even into the green leaf itself, have been recorded; and though their transition into the next descending form, the stamen, is rare, yet the latter has been known to produce ovula.

7. But it may be asked whether the existence of one organ in the place of another undeveloped, or even the partial change of one structure into that of another, is sufficient to allow us to say that a common plan of arrangement is to be seen or allowed in such abnormal or undeveloped structures, when *normally evolved*, as is seen in the organ here assumed as their type, and which sometimes exists in lieu of them.

8. In the vegetable, as in the animal kingdom, there is only one force regulating the development

and co-ordination of the parts of the organized body, namely, that exemplified in an evolution from centre to circumference. (See Virey, Philosophie de l'Histoire Naturelle; and Baer, Evolutio omnis e centro ad peripheriam tendit.

9. The law of equiponderation is seen governing the disposition of the several parts, so that it results that if one part is exaggerated, its opposing one is debilitated according to the laws of an inevitable antagonism, though the equilibrium of the organized body, as a whole, is endeavoured to be preserved by a ponderation of something else, though that of a part of it may be destroyed. For instance, in Atropa Belladonna it may seem that one leaf of the pair is larger than its opposed one, whilst the small leaf of the pair above is over this large one, and not all the small leaves and all the large leaves over each other.

10. Most of the organized bodies on the globe of which a single individual is endowed with both sexes, effect a radiating form in general, (La forme rayonnante of the French writers), as is seen in the flower of plants, and among certain of the lower animals.

11. Besides the radiating tendency, in all is seen the spiral disposition of the several parts upon the axis both in plants and animals, as shown by Brown and Schimper in the one case, and Mandl in the other.

12. Suppose we mark one leaf in a plant with the fraction 0, and then those that succeed it with 1 2 3 4 5, &c., and then trace up from the base of the leaf 0 to that of the others, we shall find we are describing a spire, and that after a certain number of turns of it another leaf is found placed exactly over the one we marked 0; suppose that this ensued in 13 turns round the axis, we then say $\frac{13}{\ }$ for a numerator; and that from the leaf 0 to the opposite one there existed 34 leaves, we then place $\frac{\ }{34}$ as a denominator, so that $\frac{13}{34}$ represents the rule of the spire.

13. In regard to the animal kingdom we may re-

mark that Mandl has examined with attention their tissues, and has been struck with the regularity of their disposition. The scales on the surface of fish, of serpents, lizards, etc., the feathers of birds, etc., etc., are all stated as being *spirally disposed round a more or less compressed cylinder, the axis of which runs through the middle of the body.* To the article of Mandl on the spiral disposition of the tegumentary appendages of animals, to be found in the 9th Vol. of 2nd series of the Annales des Sciences Naturelles, the reader is referred.

DIVISION III.

PHYSIOLOGY.

1. We have now to consider the various phenomena seen to take place in the living plant, and by which such living body is essentially distinguished from the dead. These phenomena, or *functions*, as we now term them, are manifestly separated from all other processes going on in nature, by their being subject to laws peculiarly their own, denominated laws of *vitality;* the evidences of such laws, taken separately, being called *vital actions*, and which viewed in the aggregate, constitute *life*. In entering upon this subject it is of the utmost importance for the student to remember, that in organized bodies phenomena are to be seen which are neither produced by the powers of, nor act in obedience to the laws of chemistry and physics; and that however readily electricity, galvanism, endosmose and exosmose, &c., have been brought forward to explain them, they are essentially defective in relation to the first principles of the philosophy of living bodies as established by the evidences of nature; and that it were to be wished that the remark of one of the most philosophical writers on medicine in this country was more often kept in view, as applicable to the study of all living bodies, "that the first important step in medical science is the

separation of the phenomena of the living body from all those which are comprised in the sciences of chemistry and mechanics on the one hand, and of pure metaphysics on the other; and the general acknowledgment of referring all the facts which the human body presents in health and disease, to laws of vitality, *exemplified in the history of other living bodies*, but not in other departments of naturè."—(Alison of Edinburgh.) It is not the design of this work to enter into a consideration of the general conditions of vital action, or of the vital powers or forces by which these vital actions are maintained, but to proceed at once to a notice of those different functions and processes of the bódy which are always a more or less complicated series of them.

2. Before speaking of the various functional processes in detail observed to take place in a living plant, we may notice here shortly the office of the elementary forms of structure.

3. *Cellular tissue* is capable of transmitting fluid and secreting properly elaborated material where no other tissue exists; it acts as a reservoir for nourishment for the plant at certain periods, and as a receptacle for its secreted products and juices; it binds and connects the various compound organs of a plant firmly together, and must be looked upon as analogous to the cellular parenchyma of animal structures.

4. *Fibre* supports and strengthens the plant by its firmness and tenacity, and is capable of transmitting the fluids both upwards and downwards, and is sometimes a receptacle of colouring and secreted matters.

5. *Vascular tissue*,* consisting of spiral vessels and ducts, present, in regard to the functions of the former, some difficulty; many physiologists consider their function to be that of merely conveying air at all times, whilst others have argued for their transmission of fluids: to me the argument seems to be in favour of the supposition that the spiral vessels do at certain periods of the plant's life convey fluid, though they may at

others be found merely containing air: this air has been analysed by Bischoff and Focke, the former stating it to be rich in oxygen, and the other in carbonic acid; but, as Meyen remarks, it must vary at different periods of the day, as in fact Bischoff experienced. In regard to *ducts*, the period allotted to their conveyance of fluid is probably greater than that of spiral vessels, as is also the velocity and ease of its conduction; and in the *proper ducts* the transmission of the fully elaborated juice, the true sap, evidently takes place.

6. *Intercellular substance, air cells, air passages, receptacles of secretion,* etc., betray their office by their name.

7. We shall now speak of the various *functions* of the plant in detail, commencing with those actions which take place at what may be termed the birth of the new being, and proceed gradually up to that period of its life when it comsummates all it was in one respect intended for, the production of other creatures like itself.

GERMINATION.

8. Under germination we are to consider the bursting forth of the embryo of a seed, when placed under certain and proper conditions, into a new and progressively perfect plant; the circumstances seen to accompany it, and the conditions that must necessarily exist for such processes to ensue.

9. The essential conditions of germination are the presence of oxygen, and a certain degree of temperature; but in a general way we may say they are *water* and a due *degree of heat,* as in most cases it is probable that the oxygen is obtained by the decomposition of that fluid.

10. When a seed is sown under common circumstances, one of the first indications of the act of germination is a swelling of it from the moisture it imbibes,

this softens the structures soon to be brought more actively into play, dissolves or renders soluble others necessary for the further prosecution of the process, and offers by its decomposition the necessary element, oxygen.

11. This fluid has found entrance into the seed by imbibition through its *testa;* though in some cases, perhaps, where this is very hard and not easily penetrable, it passes through the *micropyle;* the quantity imbibed, in some experiments of Edwards and Collin, was found to be equal to the weight of the seed itself.

12. In 1777, Scheele stated that the presence of *oxygen* was absolutely necessary for germination to take place, and that the air in which seeds were made to grow underwent no change of volume, but that its *oxygen* disappeared and a quantity of *carbonic acid* was produced equal to it; since which time the numerous experiments which have been made leave no doubt upon the mind of the necessity of *oxygen* being *taken in* by the seed, and likewise of the expulsion *of carbonic acid from it.*

13. Till lately it was thought that this oxygen was obtained only from the atmosphere itself, but it has been shown by Edwards and Collin that it is also by the decomposition of water that this element is procured; and besides this fact of the decomposition of water by the seed during germination, they have likewise stated that the other element of it, hydrogen, is absorbed by the seed either wholly or in part, and which has been confirmed by Boussingsalt.

14. Now it must be remembered that the seed before germination contains a considerable quantity of *carbon* and *fecula*, and that the power of losing to a certain extent this carbon, constitutes a preliminary step in the process of germination, whilst the conversion of the fecula into *saccharine matter* goes on almost synchronously with it.

15. From what has lately been shown, and accordant with what we have stated, we may say that during

germination water is decomposed, and most probably air as well; part of the oxygen so obtained combines with some of the carbon of the seed, and carbonic acid is evolved equal in volume to the oxygen so consumed; another part combines with the rest of the carbon, and *part* of the hydrogen left free by the decomposition of the water and *acetic acid* is given off, whilst the rest of the hydrogen remains fixed; the fecula or starchy matter becoming converted into sugar or saccharine material whilst these processes have been going on.

16. This conversion of the fecula into sugar during the act of germination is of chief importance to remember, and it is this which we see taking place daily in the process of malting, and in the following table from Proust, it will be seen what changes ensue.

	Grain containing before Germination.	*Containing after Germination.*
Yellow Resin	1	1
Gum	4	15
Sugar	5	15
Gluten	3	1
Starch	32	56
Hordein	55	12

Now, as Dr. R. D. Thomsons remarks, we may here observe that the gum has increased 11 per cent, and the sugar 10 per cent, thus affording 21 per cent of additional fermentable matter; the gluten has diminished 2 per cent, and there is little doubt but that the original quantity of starch ought to have been estimated at 8 per cent, and that *hordein* consists merely of starch whose properties are obscured by the presence of gluten. The additional gum is produced at the expense of the starch, and the sugar proceeds first from the starch in the form of gum, and then is transformed into sugar.

17. In consequence of the carbonic acid evolved during germination being equal in volume to the oxygen employed, and as we know that $C \times O^2 =: C$, or $O \boxminus + \square C =: C \square$, a considerable quantity of spe-

cific heat must be evolved; and this we find taking place during germination, and is especially observable during the malting of Barley, in which the grain attains during the space of 96 hours an increase of temperature of 10 degrees, and afterwards, if the grain is not turned frequently, it will rise as high as 80° Fah.

18. Besides the necessity of the gaseous bodies we have already spoken of, *nitrogen* seems also to be employed during germination; this was noticed by Saussure in his experiments, who uniformly found that azote was absorbed, though Priestley perhaps was the first who remarked the circumstance. Boussingsalt has lately confirmed the previous statements, and has come to the conclusion that some plants derive azote from the air, though others do not.

19. We have stated that a certain degree of heat is necessary for germination to ensue, and it is generally said no seed will germinate at a temperature below the freezing point of water; Edwards and Collin say, not below 44° Fah.; Goeppert allows to 37° Fah. The subject requires further investigation in relation to some cases, as in Nova Zembla, for instance, where plants are to be seen in flower in a soil whose highest temperature at the time is only 34° Fah. According to the last-mentioned observer no degree of cold can destroy the *vitality* of a seed, if it be perfectly dry, or have absorbed no moisture.

20. The degree of ascending temperature that seeds will bear, is various; some have borne that of 235° with impunity, whilst 113° has been fatal to some; much depends, however, on the hygrometric relations of the heated air and seed: fluctuations of temperature are generally detrimental.

21. It being known what influence warmth, moisture, and oxygen, etc., have upon germination, it has been endeavoured to accelerate or retard the process by artificial means. Chlorine seems to accelerate it more than any thing else; as in a few cases also does the entle boiling of the seeds; but atmospheres of pure

oxygen, nitrogen, hydrogen, or carbonic acid, are detrimental.

22. Supposing a seed is prevented from being exposed to any of the conditions we have now mentioned, it may be preserved in a state of slumbering vitality for an immense length of time, and this seems to depend upon the long power of endurance of the starchy matter it contains; but on the other hand many seeds will remain as *seeds* under the most peculiar circumstances, even embracing some of the conditions necessary for germination to take place. In the transactions of the Linnæan Society of Bordeaux, is related the opening of some Roman tombs which contained in their coffins seeds of Heliotropium Europæ, etc., and which still retained their powers of germination; and Passalacca brought from the ruins of Thebes some grains which, when examined by Fontenelle, were found to contain their proper proportion of starch, but no gluten.

23. The seed, however, being favourable to the process of germination, and placed under its proper conditions, and the changes we have spoken of having more or less ensued, the expulsion of the radicle of the embryo beyond or out of the cotyledons is seen to take place; in the case of Monocotyledonous plants the radicle of the embryo in bursting through its coats becomes enclosed within a sheath, whilst in Dicotyledonous plants it is free and uncovered, the point of its exit being generally at the hilum; the *cotyledons* either remain below ground whilst the *plumula* ascends, or they rise above it and appear as leafy expansions; in Monocotyledonous plants the cotyledonary body remains within its envelopes.

24. Upon the exit of the radicle it at once directs itself downwards beneath the earth, and sooner or later, whatever obstacles may be thrown in the way of its so doing, it will effect its object. Till very lately this direction of the radicle was supposed impossible to be overcome; but it is stated to have been effected by placing mirrors over the seeds during germination, so

that light was thrown upon them from below upwards; they then sent their radicles upwards, and plumula downwards.

25. Though it is the general rule that the radicle tends towards the centre of the earth, an exception may be found in the parasitical plant, the Miseltoe, in which the radicle obeys the attraction of the body upon which it germinates.

26. With this lengthening of the radicle and direction of it *beneath* the earth, and the elevation of the cotyledons above it, which become green by the fixation of carbon within their tissue, the plumula becomes more and more evolved in consequence of the exciting action of the nutritious matter already absorbed by the radicle, (though in some cases it is much dependent upon the raised cotyledons,) and becomes at length expanded into the perfect leaf, after which the cotyledons soon cease to exist.

27. The plumula, like the radicle, has an equally strong tendency to a particular direction, and which is equally unalterable, its direction being upwards to the light. From the experiments of Schultz we perhaps may conclude that light is the object which the radicle endeavours to avoid, and so causes its direction downwards, whilst it is that which the plumula seeks, and so gives rise to its tendency upwards; but whatever may be the cause, the *primary tendency* exists in the embryo portions as a true and determinate vital action, subject in its proximate causes to a power strictly of vitality, though its more ultimate ones may be looked for elsewhere.

28. We have now the young plant so far developed; the descending axis is carrying on its office of procuring material for still further development, and the expanded plumula is also performing its functions; all further progress being dependent upon the due performance of the process of nutrition, which operation we shall now consider.

NUTRITION.

29. All vegetable life in whatever form presented to us, is essentially dependent for its continuance on the process of nutrition, and this therefore must be considered as one of the fundamental objects of all living plants, and the conditions necessary for the performance of it as the most fundamental laws of their vitality.

30. Absorption is the mode by which the entrance of nutritious matter finds its way into the plant, and this seems to take place in a simple though active manner, no contraction of living solids accompanying the process.

31. The root is the chief organ by which absorption of such matter takes place, though no doubt can exist that the leaves, &c., lend their aid, though to a less degree.

32. It has been supposed that at a particular portion of the root (the spongiole or extremity of the radicle) absorption alone takes place, and the experiments of Senebier and others are adduced in support of it; nevertheless, it was known to De la Baisse before him, that this is not alone the absorbing surface; and from later experiments we may conclude the surface of the root generally absorbs, though the quantity and velocity of the absorption may be comparatively small to that seen taking place at the extremities of the radicles.

33. Whatever nutritive material is absorbed by the roots, it must be held in *complete* solution in water; no substances, either solid or mechanically mixed with it, can find entrance into the plant.

34. Some persons believe that roots will absorb colouring matter along with the water in which they are grown; and Biot has said that he coloured the white flowers of a Hyacynth, by making it absorb the juice of Phytollacca dicandra; this same experiment has been instituted for more than one hundred years, according to another writer, but the results obtained at different times

have not tallied with each other: from many experiments upon this subject, we are inclined to believe that so long as the extremities of the radicles are in an unhurt and whole condition, absorption of colouring material will not take place. Hyacinths reared by us in solutions of very pure Carmine and Indigo, showed no trace of these colours in the structure of the radicles under the microscope, though perhaps it may be said these colours are not fine enough for absorption of them to ensue.

35. Much dispute has arisen as to whether pure water alone is sufficient for a plant to grow and flourish in, or whether it requires something else beyond: experiments might be adduced in favour of both sides of the question, but unfortunately in regard to many of them we have still to learn what was understood and employed as *pure water* in the experiments. Braconnot used, it is said, *distilled water*, but other circumstances render his experiments not to be relied upon. For ourselves, we believe that for the mere existence of vegetable life, up to a limited period, distilled water may serve as soil for the plant to grow in, but that for the higher maturation of vegetable life, something is required beyond. The difficulty in this question is as to the *purity* of the water employed, and the impossibility of any matters becoming somehow or other connected with it during the experiments, and this difficulty is increased by the fact that the plant for a certain period will live as it were upon itself; nevertheless, seeds are said to have been produced and ripened under the influence of *pure* water and air alone.

36. Water in all cases is taken in by plants in much larger proportion than anything else; but whether this water becomes merely fixed and remains undecomposed within the plant, or whether it is decomposed and its elements enter into combinations anew, is at present doubtful; most likely both circumstances take place.

37. Whatever else may be *useful* for the proper development of a particular individual, *carbonic acid* is *most*

essential for all; but besides carbonic acid and water, the existence of nitrogen, in some combination or other, from which the plant may derive it, is highly necessary to *many*.

38. Besides water, carbonic acid, and azotised material, which may be looked upon as the chief sources of the nutrition of plants, it is well known that for the perfect development, and even for the mere existence of certain species, something else is required to exist in the soil in which they grow; and from late experiments we are at liberty to conclude that the plant by its roots possesses a power of selecting the material useful for it.

39. That inorganic substances existing in the soil are taken in by the plant, is evident enough from daily observation, but the difficulty is to determine what part as regards nutrition they are called upon to perform: some seeds of a Sun-flower were sown in a sandy soil which was destitute of saltpetre, and the plants that grew in it gave none of this salt on analysis, whilst some others grown in the same soil, but watered with the salt in solution, presented it in their intimate structure. That the saltpetre was not essential to the existence of the Sun-flowers, although absorbed by some of them, is plain; and experiments of Saussure prove that plants will to a certain extent absorb substances, whether useful or not, or even detrimental to them.

40. We know whole hosts of plants, however, that only thrive in a particular soil, the necessity of which to them arises from its containing some ingredient necessary for their support or vigour, and which ingredient we find both in the soil and plants grown in it when submitted to analysis; such, for instance, as *maritime* plants growing in situations where the salts of Potassa and Soda exist in the soil, and which plants are employed to yield them again for commercial purposes, and to the welfare of which the presence of these salts in considerable quantity seems necessary.

41. It is sometimes difficult also to trace the relation

that the principles found in the plants themselves bear to those of the soil in which they have grown, for substances have been said to have been found in plants which never could have been taken from the soil; it has therefore been thought that plants, by virtue of the vital powers of nutrition, could form certain inorganic products out of the elements of others taken in by them. This is now supposed not to be the case, but, on the contrary, that all the inorganic bases of the matters found have been absorbed by the plant, and not produced within them.

42. It has been said that plants might be grown in any thing as a soil, and the experiments of Schrader, Braconnot, and Sukkow, are adduced as examples; in their experiments seeds were said to have germinated in sublimated sulphur, sand, silver tinsel; and on slips of paper, old books, &c., by Bonnet: and though in the former cases, only moistened with distilled water, organic and inorganic substances increased within the plants; the later experiments of Lassaignes, Jablonski, and others, have proved that under these conditions it is only up to a certain period that the life of the plants so produced can be maintained, and that is dependent, not upon the soil, but upon the plants' own reservoirs of nutritious matter.

43. Latterly considerable light has been thrown upon the knowledge of soils in general, by Boussingsalt. It is universally known, as a general rule, that all plants will thrive better in good garden mould than in a common field, unless the latter contains some particular ingredient for which a plant has a marked affinity; and Woodward and Kylbel have shown that garden mould contains a particular extractive matter, a source of very great nourishment to the plant growing in it. From analysis of this mould, which has its origin in the decomposition of various vegetable matters, it has been stated to consist of earthy extract, earthy acid, earthy carbonaceous matter, besides saline ingredients; the quantity of the extract in good garden mould was 10 to 4.

The earthy acid called *ulmin* by Braconnot, and the carbonaceous matter, are isomeric bodies. The quantity of the extract, says Saussure, which boiling water separates from mould, is not much, but the great nourishing property of it is strikingly illustrated in the fact that when seeds were grown in mould which had not been boiled, the plants were one quarter greater than they were when the mould had been boiled.

44. At one time it was thought that nitrogen had little or nothing to do in respect to the nourishment of plants, and few cases only were supposed to exist in which this element seemed an active ingredient. Gay Lussac proved its presence in a very great number of seeds, and lately Boussingsalt has followed him with like results, and shown that Vetches, Lentils, and Beans, have from 4 to 5 per cent, whilst Clover contains 7. Besides this the presence of azote in the other organs of vegetables, is now demonstrated more frequently than before; and Hermbstadt has shown that the cereal grasses cultivated under the influence of the most fully azotised soils, contain most gluten; and it is highly probable that the deterioration of a soil by crops grown in it, depends on a great measure on the loss of its nitrogen abstracted from it by the plants.

45. Although we must undoubtedly say with Thaer, Boussingsalt, and others, that the manure or mould is the agent contributing most efficaciously to the nourishment of plants, and that the force of vegetation is determined by the proportion of the nutritive fluids which they there meet with, yet they likewise derive much from the atmosphere and the objects contained in it, and which find an entrance into the plant by means of the leaves and foliaceous parts, &c.; but this we shall notice a little further on.

46. *Sap.* The fluid along with its contained nutritious materials, as soon as it enters the plant receives the name of common or crude sap, but which is to be distinguished from the true or proper sap, which is the former properly digested in the leaves.

47. The crude sap has to be conveyed from the root to the leaves, and the structures through which the transmission takes place vary according to the rank of the plant. In Dicotyledonous plants the upward course of the sap is through the fibrous or woody tissue and ducts of the woody layers, and chiefly of those last formed, the alburnum; but I think the observations of Gaudichaud, Meyen, and others, prove that it takes place at a certain and limited period through the spiral vessels. In Monocotyledons no doubt a very considerable portion is transmitted by the cellular tissue, in which the more limited vascular one is embedded, and by the ducts also perhaps more than by the woody fibre; but in all cases besides the mere upward course there is likewise a ready lateral motion of the fluid by which all parts of the plant are permeated; this lateral transmission takes place by means of the cellular tissue, and the medullary rays when they exist are especial media.

48. In regard to the cause of the motion of the sap, many have been the theories: Malpighi, Brugmans, etc., believed in an irritability of the smaller vessels, and lately Decandolle has put forward a vital contractility of the cells analogous to the systolic and diastolic motions of the heart; Knight believed in a hygrometrical property of the medullary rays; Du Trochet, in the powers of endosmose and exosmose; Du Petit Thouars in the expansion of the buds at spring attracting a certain quantity of sap from situations near them, and so causing the sap *below* to ascend and fill its place; and Hales states, that "no other cause can be discovered than the strong attraction of the capillary sap vessels, assisted by the brisk undulations and vibrations caused by the sun's warmth; but the ascending velocity is principally accelerated by the plentiful perspiration of the leaves."

49. In regard to these various theories we may remark, that there is as yet no distinct and satisfactory evidence of a contractile power in the solids through which the crude sap passes; that although endosmose and ex-

osmose often exist, as a philosophical writer before quoted remarks, as actions going on in living structures causing in them motions of their fluids, it is equally true that they exist even in unorganized structures; and as a consequence of which no strictly vital changes are seen to follow; and also that vital phenomena seemingly in close analogy to what, we are at present referring to, often exist when the conditions of endosmose and exosmose never do: and further we know the vital phenomena, which it undertakes to explain, are liable to great and often sudden changes and modifications from various stimuli and sedative poisons, and from injuries, and which have no such effect upon this or upon any other purely physical principles. In regard to the view of Du Petit Thouars, one difficulty, it appears to me, may be stated; if the buds swell in the spring by warmth producing rarefaction, (for they cannot by the entrance of more sap into them, as it is supposed not to have begun to move yet), the fluids contained in and near them will be rarified too, and therefore instead of attracting the circumjacent fluid to fill up vacant space, and so give rise to the ascending motion, it would occupy larger space than it did before, and press the rest down towards the roots. Finally, we know that the motion of the sap takes place most vigorously when transpiration is at its lowest ebb, likewise in plants growing under water; and also that the absorption and motion of the sap in some cases greatly exceed anything like the transpiration which takes place, as shown by Humboldt, in which an Agave when cut yielded 200 cubic inches of fluid in twenty-four hours; whilst in this plant transpiration is very little indeed.

50. In regard to this subject, in our present state of knowledge, I believe we must allow that the ascent and motion of the sap, though materially modified by many of the circumstances already mentioned, is one of those actions resulting from a combination of certain vital principles, one of which is vital affinity, by which the elements of the nutritious matter must be thrown into

the peculiar combinations necessary for forming the organic compounds; and, secondly, some moving power peculiar to life, in all probability of the nature of attraction and repulsion, by which the particles of that matter must be moved in the directions necessary for these combinations, and that such powers do exist, researches into other phenomena of organized bodies seem fully to prove. In regard to the regular ascent of the sap at certain periods, as in spring, light and heat may be looked upon as awakening stimuli to the vital powers; but independently of this there seems to be no reason to deny (and some facts prove it) that it has its origin to a certain extent in *a tendency to a periodicity of action, the exciting causes of which are to be sought for in the plant itself.*

51. The sap, in the course of its transmission from the root to the leaves, suffers some change; part of the water, nitrogen, carbon, and soluble materials are deposited; whilst a preparation for these and other elements to enter into new combinations is generally going on.

52. *Digestion.* On its arrival at the leaves more particular changes are seen, the fundamental ones of which appear to be the superfluous water is given off from the leaves by exhalation, carbonic acid is decomposed, the oxygen is parted with, whilst the carbon is retained; besides this, however, certain other processes take place in order to render the digestion of plants complete. Water, at certain periods, and in many plants nitrogen, is inhaled by the leaves.

53. The decomposition of carbonic acid in the leaves during the process of digestion, is one of the most important points to remember, and also that this decomposition only takes place under the influence of light.

54. Though evolution of oxygen only takes place under the influence of solar light, when the plants are growing naturally, only a very modified degree of it is *essential*; this evolution of oxygen from the leaves of plants during the day-time, must not be looked

upon as produced by the chemical action of light upon the carbonic acid, but as acting on the vital processes influencing nutrition, as suggested by Link, and so producing the decomposition of that gas; and the more the vital powers of the plant are hurt, the more strong must be the stimulus to awaken these actions, as shown by those experiments made upon plants more or less deprived of their natural relations, in which a softened or more moderate light causes no evolution of oxygen from the leaves, but the influence of the *direct* solar rays are required.

55. From various experiments we are also to conclude that the quantity of oxygen evolved is equal to the quantity of carbonic acid absorbed by the plant.

56. The carbon that remains after oxygen is thus set free, contributes to the formation of the various organic products found in the plants, which are either useful to it as nourishment, or are hereafter to be discarded; but a superfluous portion of it left by the process of digestion at the time, is removed from the plant by means of the function of respiration.

57. That nitrogen enters the plant by means of the sap, no doubt can exist; but that it is likewise obtained for digestion by means of the leaves from the air is more doubtful, though late experiments seem to prove that some plants do so obtain it, whilst it is inappreciable in others.

58. The exhalation of moisture from the leaves during digestion is continually going on, but the quantity given off is much modified by circumstances, and which regulate likewise the quantity inhaled. During the night exhalation is very slight, or indeed ceases, and is greatest during the day-time when the atmosphere is hot and dry, though light seems to have more influence upon it than does temperature itself. According to some, two kinds of transpiration are to be seen in plants; the first is that which plants have in common with all humid bodies, and is termed *insensible waste* (deperdition insensible), whilst the other is dependent at

once upon digestion, and is termed *watery exhalation.* According to Miquel and Decandolle, heat has a sensible action upon the increase of the former, whilst within certain limits it has very little upon the latter.

59. The loss of water by the plant from exhalation at the leaves, is accompanied also by the absorption at the same place of fresh quantities generally exceeding in amount the former, though the reverse in some cases may hold good.

60. In a general way we may say that plants with tender leaves transpire more than those of a firm and coriaceous texture, and that in Evergreens the exhalation is but very little in comparison with other plants; and Hales calculated that fleshy fruits transpire the same quantity that leaves do in relation to the extent of exhaling surface.

61. *Circulation.* We have now to speak of a very complex subject connected with the nutrition of plants, and regarding which at the present moment it is difficult to arrive at a definite conclusion. This subject is the motion of elaborated fluid through different parts of the plant, and which in some of its relationships is held to be analogous to the circulation of the blood in animals.

62. In the observations which follow, the views of Meyen, of Berlin, upon this point, are those which are regarded, and which will be found fully developed in the 2nd Vol. of his System of Physiology, the nature of this work forbidding all lengthened and controversial points being entered into.

63. In 1772, an Abbot and Professor of Physic at Reggio, Corti, discovered a motion of fluid taking place in the cells of certain plants called Charas, since which time up to the present period numerous observations have been made upon these and other plants in which nearly a similar motion has been seen to take place.

64. The Charas are plants situated low down in the scale of vegetable bodies, being more nearly allied to the Confervæ than to any others perhaps, but forming a

separate division called Characeæ, and are found in our own country in ponds, and sluggish streams of water; they consist of simple tubes or cells placed one above the other, but having no communication from cell to cell, the membrane composing which is more or less transparent, but in some cases covered with a layer of carbonate of lime.

65. When a portion of a transparent Chara is examined with the microscope, an incessant movement of little globules is seen along the side of each cell, turning round at the top and running down the other side, then turning round at the bottom, and so repeating a continuous motion along the inner surface of each cell. The relative position and connection of these globules one with another, show that they are quite passive themselves, but are swimming in a fluid which is moving them along: now to this motion the term *rotation* is applied.

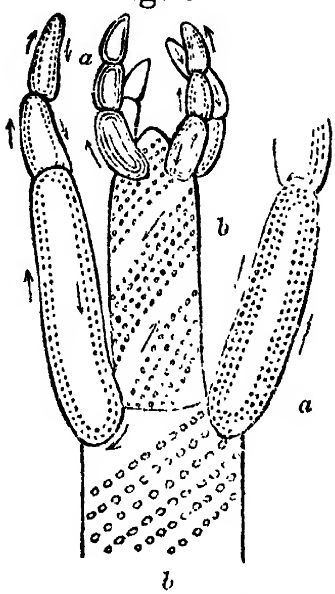


Fig. 52.

66. The direction of the *streams of rotation* in the cells, depends upon the following circumstance:—Within the cell, upon its inner surface, are placed a number of green-coloured little bodies, arranged as at fig. 52. In the youngest cells of the plant they are seated parallel to the longitudinal axis of the cell (as at *a*), whilst in the old ones they are in a spiral arrangement around it (*b*); the space which is left between the series of green bodies being termed by Du Trochet *line of repose*.

67. However these bodies may be placed, the *streams of rotation* always follow their direction, and no motion is to be observed except over where they are situated.

68. These currents take place in each cell, which is perfectly close, and no connection exists with the cur-

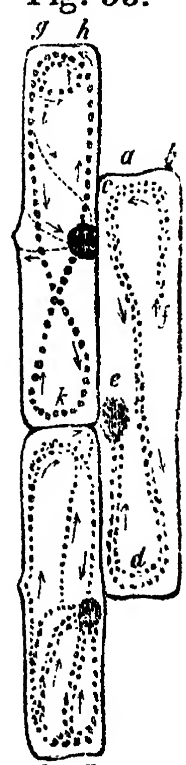
rents of the other cells; and there is no separating medium between the upward and downward streams of each cell individually, although they continue perfectly distinct from each other, and whatever may be the position of the plant, preserve their original direction.

69. The rapidity of the streams varies according to the age of the plant, and its vegetative vigour and warmth has much influence upon it; a range of temperature between 53° Fah. and 77° is most favourable for its continuance, according to Du Trochet.

70. Besides the existence of *streams of rotation* in the plants we have described, they are likewise to be seen in many of the higher orders; but the direction of the streams though taking place in closed cells is somewhat different to that seen in Chara, and by Schultz they are considered of an entirely different nature.

71. This modification of rotation is well seen in Tradescantia virginica, and may be illustrated by the following description from Meyen. The annexed figure represents three cells from the stem of Tradescantia ciliata; in the cell *a b*, the most simple form of rotation is seen in a single stream of a spiral direction running from *c* to *d*, where it turns round and runs to the nucleus *e*, passing along the other side of the cell to *f*; in *g h* there is a point especially to be noticed, the fine stream running from *i* to *k*, and which at *i* runs at the end of the cell, gives off some fine molecules and other matter, which take upon themselves a distinct rotary motion independent of that of the main stream, as is marked by the arrows; this separated rotation does not, however, last long, but returns to the original stream.* In *l m* small streams are seen connecting the two main streams together, and meeting at the nucleus.

Fig. 53.



72. In the higher orders of plants, that is in the Monocotyledonous and Dicotyledonous divisions, a particular motion of elaborated fluid is seen taking place in some of those vessels which we denominated, under the division of Anatomy, *proper ducts*, and to which the term *cyclosis* is applied.

73. The fluid contained in these vessels which ramify amongst most portions of a plant, is denominated *latex* by Schultz, and *milk juice* by others; according to some, it has its origin in the sap before that fluid has been elaborated in the leaves, and then passes into the leaves in order to undergo elaboration itself, from whence it passes over the plant into the bark through the vessels we have named: it consists of two portions, a colourless *serous*, and a *thick consistent coagulable* part; in most cases also it contains a great number of little globules possessed of a peculiar molecular motion, and likewise a number of other bodies of various forms, chiefly composed of starch or gum, the whole latex varying in colour according to the species in which it is examined.

74. According to Meyen this fluid moves along the proper ducts, (or cynenchyma of authors), which form a continuous anastomosing system of vessels running along the stem, and through the tissue of its various appendages, but most evidently seen in the inner layers of the bark.

75. The fluid rises in some of the main vessels running in a parallel direction with the course of the stem from the root to the leaves, which latter it traverses by means of the various branches of the vessels, and turns back again through the smallest ones in order to arrive again at the main vessels in the trunk, from thence running to the root which it traverses like the leaves, and there receiving a considerable addition of crude sap commences the same circulation anew. In vigorous plants during the warmer months of the year the motion of the latex is very rapid, and often far quicker than that of the blood of the amphibia; at a low tempe-

rature it becomes slower, and ceases at the freezing point of water.

76. In regard to these motions seen to take place in plants, an analogy has been drawn between them and the circulation of the blood in animals, and were it not that plants are destitute of a central system or organ from which the moving fluids set out and to which they return, as in the higher beings, (although it may be maintained, as Schultz has done, that there are certain foci to be demonstrated,) a considerable degree of pro-probability might attach to the supposition.

77. The difference between rotation and cyclosis is differently marked by Schultz than in the forementioned paragraphs, as he considers that rotation is never seen in plants in which cyclosis is met with, and that it is strictly confined to the lowest tribes; and that what is termed rotation in the others, is but a form of cyclosis under peculiar modifications, and also that cyclosis is not to be seen in the lowest orders of plants.

78. The causes of the motions of *rotation* and *cyclosis* are strictly vital; electricity, galvanism, and contractions of solids, etc., all fail in its explanation, as even acknowledged by non-vitalists of the day; and the conclusion that we can only come to is that already expressed in paragraph 50, when speaking of the causes of the motion of the crude sap.

RESPIRATION.

79. Essentially connected with the performance of nutrition is the function we have now to speak of, namely, that of *respiration*. We have seen under digestion that by the decomposition of carbonic acid oxygen is *evolved* by the leaves, and that its carbon is retained; in this process, on the other hand, oxygen is *absorbed*, and carbonic acid is evolved. Until lately the *evolution* of oxygen was considered as belonging to this function,

which was supposed to consist in an absorption of oxygen and evolution of carbonic acid by night, and an evolution of oxygen along with absorption of carbonic acid by day; this last, however, is to be more properly looked upon as dependent upon digestion, and has been before explained.

80. The process of respiration essentially consists in the plant at all times inhaling oxygen from the air by means of the leaves, and other foliaceous parts, etc., which combines with a portion of the carbon left free during digestion, and is now given off in the form of carbonic acid. It is probable, however, that the *whole amount* of oxygen taken in by the leaves is not at once employed in removing the superfluous carbon unrequired for elaborative purposes, but that some portion of it is absorbed into the nourishing juices of the plant to serve particular purposes in its economy.

81. In looking at the processes which take place during respiration and digestion, it will be seen that during the former a plant is continually depriving the air in which it grows of a portion of its oxygen, and loading it with carbonic acid, whilst in the other again oxygen is restored to it, and some of its carbonic acid is removed for the purposes of nutrition.

82. As the evolution of oxygen from the leaves only takes place when the plant is under the influence of light, and as the absorption of it and disengagement of carbonic acid, as is fully proved, ensues at all times, it will follow that during the night, or in darkness, the air in which a plant vegetates will be vitiated and rendered detrimental to the life of another being, but that during the day-time it will either be not materially altered, or it will be rich in oxygen, according to the relative amount of oxygen evolved during digestion in relation to that absorbed during respiration. That the quantity of oxygen given off by the leaves, and the absorption of carbonic acid by them not only restores the balance arising from respiration, but even tends on the whole to materially enrich the air so deteriorated, seems evident

from experiments, so that the interesting question, Does vegetation purify or vitiate the atmosphere? may, I think, be answered in the affirmative; it must not be denied, however, that, in the opinion of many, this point is not satisfactorily proved, and that if we have Confervæ, Ulvæ and similar plants continually giving out oxygen, we have others, like the Fungi, constantly absorbing it or deteriorating the air in which they grow.

83. Connected with the subject of respiration there are many difficulties as yet not satisfactorily explained; the conditions under which this process is performed is different in different tribes, at least as regards the lower order of beings, and even the conditions under which it may be carried on in the higher orders, is not, in all cases, properly known. Sir Humphrey Davy found some plants would grow in an atmosphere of hydrogen, whilst others would not, but died. Olefiant gas, and the protoxide of nitrogen, in certain proportions, are not detrimental to the performance of respiration, whilst the $\frac{1}{1000}$ of sulphurous acid gas will destroy the plant. According to Saussure's latest experiments, when plants were growing in the shade, any addition, however small, of carbonic acid to that already existing in the air, was highly deleterious, for if the air contained a fourth part, the plant died on the sixth day, but if the quantity added was small and plenty of oxygen present, and the plant exposed to broad day-light, it would live. In an atmosphere containing much oxygen, respiration is much increased. The leaves of our trees consume the greatest quantity of oxygen, and evolve the most carbonic acid; then come vegetables, then the leaves of Evergreens; bog and water plants, and lastly, plants having fleshy leaves. The leaves of a Prunus consumed 8 parts of oxygen; of a Potatoe 2. 5; of Veronica beccabunga 1. 7; and of a Stapelia only 0. 63.

84. The leaves of plants are undoubtedly the organs by which evolution and absorption chiefly go on, whether immediately connected with respiration or digestion;

and it is not improbable, as Dr. Lindley remarks, that the cells forming the upper stratum of their parenchyma perform a function analogous to that of the stomach in animals, digesting the crude matter they receive from the stem, the lower stratum taking up the matter so altered, and submitting it to the action of the atmosphere, which must enter the leaf purely by means of the stomata. That it is by the stomata that the *exhalation* of watery matter takes place, seems to be evident also; but whether they *inhale* it likewise, or whether the absorption of fluid takes place by means of the hairs on leaves, or in consequence of a general permeability of tissue, is more doubtful. According to Saussure, the petals of plants consume more oxygen in proportion to the green leaves, the anthers more than the pistils, and single flowers more than double ones in lieu of whose generative organs petals have been developed.

GENERATION OF HEAT AND LIGHT.

85. *Heat.* John Hunter made some experiments to show that plants must be first killed by the cold before it could freeze their sap, (but which is now, however, known to be by no means the case); that the natural heat of plants varied according to the species and its native climate; that the temperature of the interior of a plant was often six degrees higher than that of the surrounding air, and that the lowering of the heat of the external air had but little influence upon the temperature of the interior of the plant. The next experiments after Hunter's, of any use, were those of Salomé, who observed the temperature of a tree by placing a thermometer nine inches deep in its stem, which was eighteen inches in diameter and eight feet above the earth; and at the same time noticed the temperature at the same depth in a dead trunk. The temperature of the living stem showed itself

independent of that of the air outside. If the external heat rose above 63° Fah., the temperature of the tree remained as it was before, and showed a lower degree than that of the atmosphere, but if the air sank from between 36° Fah. to 32°, the tree remained always between 52° and 74°: but he especially remarked that the warmth of the tree sank during rain. Numerous other experiments, which were made upon this subject, left no doubt that the temperature of the interior of a living tree during low degrees of heat of the external air, was always higher than that of the latter, but was, on the other hand, always lower when the temperature of the surrounding air was very high; the difficulty, however, was to explain this. The subject was much canvassed, and Nau proceeded to examine the question again, and came to the conclusion that there was really an internal warmth of plants, but that it had its origin only from the inability of the *air within* the plant to change its temperature synchronously with that of the *external air*, and which, according to circumstances, was sometimes warmer, and at others colder than that of the plant.

86. Of the power of plants to generate particular degrees of heat, there can be now not the least doubt, and that this generation of heat depends upon the performance of certain phenomena taking place within the plants themselves, is equally as evident, and receives its support from the following facts now to be mentioned.

87. In 1777 Lamark noticed the evolution of heat in a strong-smelling flower, the Arum italicum. Senebier afterwards described it more particularly in another plant of the same genus, and showed that the evolution of heat began in the flower so soon as the spatha expanded, that the evolution of heat was noticeable about 3 or 4 P.M. daily, and that its maximum occurred between 6 and 8 o'clock; but that the maximum of the external air was not coexistent with that of the plant, and that the difference between the two maximi was 7 degrees in favour of the plant.

88. Numerous observations were made upon this subject, and it was shown that in order that much heat should be evolved by the spadix of the Aroideæ, a considerable degree of vegetative vigour should be present in the plant, and that in its native country the heat evolved by the plant was much more considerable than in our own. We have only room to remark on this interesting subject, that the most valuable observations have been recorded by Vrolick and Vrièse; they go to prove that the evolution of heat by the spadix of Caladium odorum is very considerable at certain periods of the day, whilst at others, on the contrary, it is quite unnoticeable; (the maximum of the temperature showed itself regularly between 2 and 4 in the afternoon; whilst in the experiments of Brogniart it occurred somewhat later;) and that the heat evolved also has its origin in the spadix itself, and that the spatha or floral covering has nothing to do with it. Goeppert has stated that the seat of the evolution is to be looked for in the generative organs themselves, and that after the spadix had been cut into five pieces, that portion on which the anthers were fixed showed a high degree of temperature even at the expiration of eighteen hours.

89. The evolution of heat in the flowers of plants is not confined to the members of the family *Aroideæ*, but has been also noticed in many others: the male flowers of a Cucurbita just opened, showed between 7 and 10 A.M. half a degree centigrade of heat more than the external air; and Bignonia radicans and Polyanthes tuberosa, showed a difference between 0.3° and 0.5° cent. to the atmosphere.

90. From the numerous experiments made upon this subject, there can be no doubt of the actual evolution of warmth by plants, and that it is seen to very great perfection in the region of the reproductive organs; that the changes taking place during the vegetation of the plant, as regards the union of oxygen with carbon, are its main causes, (as seen likewise in the

process taking place during germination,) and that this evolution is greatest where the destruction of oxygen is so too, and that the more the plant is exposed to its influence, the greater is the heat; for, says Vrolick, in oxygen we see a considerable increase of size, a development full of vigour, a natural colour, a very high temperature, in fine, everything that announces a vivifying and exciting action in the whole functions; whilst in nitrogen, on the other hand, cessation of movement, stagnation of all vital action, arrested growth, colour lost, production of heat interrupted, and complete dissolution to be feared.

91. M. Dunal, although agreeing that the absorption of oxygen and its combination with carbon, are the causes of this generation of heat, supposes that this is brought about independent of respiration, and that the process is one of pure nutrition; that a formation of saccharine matter takes place in the nectary and petals, and that this is conveyed to the anthers and ovules as a nourishment for them, and that it is in the formation of this saccharine matter by the plant that the heat is evolved.

92. *Light.* In regard to the disengagement of light by plants, a few observations only can be here stated, as all circumstances connected with it are clothed in much doubt.

93. The daughter of Linnæus observed a sudden gleam of light come from the flowers of Tropæleum Majus, which fact was afterwards substantiated by Linnæus himself, and likewise by his son; Crome, on the 31st July, 1808, between 10 and 11 P.M., noticed a luminous appearance proceeding from the spur of the same flower, and which, when touched by the finger, became stronger and followed its motion. Zavadski saw the same thing, not only from this plant, but from others also; and several observers might be added who have placed upon record statements which go to prove that sudden glances of light have been seen

proceeding from the flowers of various plants, but whether they might not be resolved into electrical phenomena connected with the atmosphere, is doubtful.

94. Zavadski states that the light was seen only in the months of July and August, whilst fructification went on, and then only when the day had been warm and fine, and that it appeared soon after sunset; also that the flashes sometimes came one after the other quickly, but often after the lapse of several minutes.

95. It has been seen at night when the weather was stormy and tempestuous, and also when during the day the temperature had been 88° Fah.

96. Though, as we have stated, it may be doubtful what is due to electrical conditions of the atmosphere, we must mention that when the Arum maculatum was allowed to respire in oxygen, greater heat was developed, and *a phosphorescence* was seen; that the evolution of warmth has been generally noticed in plants of strong odour, and which, in some instances, has been the case as regards the development of light, that both heat and light have been chiefly seen when the temperature has been high, and that both occur, according to some, when fertilisation is going on, and that therefore these may be coincidences which may incline us to the opinion that the combination of oxygen with carbon is closely connected with the production of this phenomenon.

97. An appearance of a luminous nature has been noticed in the juices of some plants, but the condition of this work forbids our entering any further upon the subject; and we, therefore, must refer the student more especially to Meyen, where he will find the evolution of light as taking place during the decomposition of vegetable organic matter noticed in detail.

SECRETION.

98. From the introduction of nutritive material into the system of a plant, and the due performance of the

processes hitherto described, an elaboration of matter useful for the further support of it, and a separation of matter which is not so, but may be separated from it, both take place; but it is often difficult to say what is so useful, or what is detrimental, and may more or less be dispensed with.

99. After the crude sap has passed through the leaves and becomes altered by the process of digestion there taking place, it descends through the bark, in which it is found very materially different in nature and property, but varying according to the plant in which it is examined.

100. This fluid, to which the term Proper Juice is most correctly applied, contains different products, which are afterwards to be seen as *excretions* from the plant, though at one time many of them, along with the fluid they are contained in, serve as nourishment to it, and go to the formation of its several organs.

101. The proper juice, along with its contained products, is here looked upon for convenience of description as a secretion, though the main portion of it perhaps is at once derived as an assimilated fluid from the leaves after digestion, in which the objects to be secreted are formed after a time.

102. According to the nature of these objects which predominate, and therefore give a character to the fluid in which they are found, proper juices may be divided into three classes:

1. Resinous and gummy juices.
2. Caoutchouc juices.
3. Albuminous juices.

103. The proper juices of most plants have resin or gum as their chief ingredient: in some it is almost impossible to say which predominates. The Poppy has a juice belonging to this division, at least according to the analysis of Bucholz; and here are to be placed the juices of the milky Euphorbias, and of the trees yielding Camboge, etc.

104. The second class containing juices in which Caoutchouc predominates, includes those plants yielding Indian Rubber, as Siphonia cahuca, etc.; but this substance is also found in the juice of many other plants, though in less quantity, as in Papavaraceœ, Compositœ, etc. It has been shown that in the juice of the young branches of Ficus elastica, instead of caoutchouc, Viscin is found, whilst in the other parts of the tree no viscin, but caoutchouc is seen. It is probable that this viscin is an incomplete state of caoutchouc, containing a considerable quantity of water, which afterwards becomes converted into the latter substance at the leaves. A substance closely resembling it is to be found in the common Fig.

105. The third class whose juices contain considerable quantities of vegetable albumen and wax, is well represented by the juices of the famous Cow Tree and Papaya, interesting accounts of which will be found in the travels of Baron Humboldt.

Products composed of Oxygen, Hydrogen, and Carbon, the Oxygen and Hydrogen being in the proportions to form water.

106. *Fecula,* or starch, exists in great quantity in the vegetable kingdom, both in the higher and lower orders of plants. In the stems of some Ferns it is so abundant that a sort of bread can be prepared from it, and as obtained from the higher orders of plants, it is in daily use. Without dwelling on the well-known uses of the seeds of the cereal grasses, which, however, depend very much for the nutritive property of their Fecula upon its combination with *gluten,* we may remark that amylaceous matter exists in abundance in the seeds of all plants, in tuberous roots, and the enlargements at the base of Monocotyledonous stems. From the pith of some trees it is obtained in considera-

ble quantity, and forms the Sago, Arrowroot, Cassava Tapioca, and Salop, etc., etc., of commerce.

107. In the tubers of the Orchises, and other plants when examined by the microscope, the Fecula may be seen as minute globules; these globules of amylaceous matter when placed in water, of 112° expand, but the temperature of 212° causes the bladders to burst, when, that which was contained within them is deposited in the water, whilst the rest is precipitated: that contained in solution is the *Dextrine* of Biot. If the solution is filtered and Iodine added to it, a yellowish brown colour is produced, but if added to the precipitate a blue or violet colour appears; showing therefore that the grains of Fecula are composed of different substances, and that as a test of starch, Iodine acts upon the *coats* or *external portions* of the grains, with which it only produces a blue colour.

108. A principle termed *Diatase* also exists in starch, the action of which upon fresh Fecula is peculiar. According to Guerrin, if 100 parts of starch are dissolved in 1393 of water, and mixed with only a little more than twelve parts of Diatase, and subjected to a temperature of 68° Fah., 77.64 parts of sugar are obtained, whilst upon a great number of other vegetable substances Diatase it has no action at all.

109. The characters which mark the nature of amylaceous matter are thus summed up by Payen. A complete insolubility in water and alcohol, both directly and at low temperature, a great extensibility, and a remarkable contractility under the influence of several agents, a blue or slightly violet colour, when acted upon by the solution of Iodine, the augmentation and predominance of the colour red in this combination, and its great instability during the progress of the disaggregation of the grains of Fecula, and at last a complete cessation of all colourability by means of Iodine as soon as the disaggregation is carried to the point representing its maximum of solubility during cold, that is to say, its complete transition to the state of *Dextrine*.

110. *Gum*, although a term often used to express substances combining several different compounds, and even containing the principle nitrogen in small quantities, is in consequence of the proportions of its oxygen and carbon noticed here.

111. Mucilage, or Gum, as found in plants, is a source of considerable nourishment to them, just as Fecula or amylaceous matter. The secretion of it takes place in the cellules; but it is often found collected in what may be termed its receptacles, which are more or less enlarged intercellular passages. Its nature varies in the different species producing it; but the best known Gum is that obtained from different species of Acacia, *Gum Arabic;* it contains a little nitrogen and a small proportion of carbonate and phosphate of lime. A Gum resembling this in its properties is procured from the Ferronia eliphantum, which is praised by painters for mixing with their colours, but it is not brought to England. Gum Tragacanth contains a peculiar principle called Cerasin, into the formation of which Bassorine enters, as also into the different sorts of Cherry-tree Gums, as they are termed.

112. The quantity of gum secreted by plants is often very great; a single slit in the bark of Anacardium Occidentale afforded a mass of forty-two pounds weight. The Astragali yielding Gum Tragacanth are said to give more of it when mists have been prevailing during the night.

113. *Sugar*, unlike starch and gum, is not met with in particular receptacles in the interior of plants; but is found in solution in the juices, especially of external organs, where it is sometimes collected in considerable quantity, and appears on the exterior of them in a crystallized state.

114. This substance presents many varieties, differing in the proportion of their elements, and the compounds they are associated with, the chief of which are Cane Sugar, Grape Sugar, Manna Sugar, etc.

115. The Sugar Cane was first used by the Chinese

in order to procure the sugar now used in commerce, and their knowledge spread into India, but in the time of the Greeks and Romans this sugar was unknown in Europe, and a saccharine material was employed which was obtained from the juices of certain Palms. In the West Indies especially, it is now obtained in large quantities for commerce by evaporation and crystallization of the juice of the Saccharum Officinarum. Lime water is added to neutralize vegetable acid, mixed with the juice; albuminous fluids, such as blood, are added to entangle and remove impurities; charcoal to destroy colouring matter; and, according to the most improved plan, the syrup is concentrated for crystallization by evaporation in vacuo.

116. The Beet-root and Plane-tree root contain much saccharine matter, and in that obtained as exuding from the bark of Fraxinus ornus, called Manna, a principle named *Mannite*, is found. According to Decandolle, Manna, occurring, in the form of tears, is caused by the injuries of insects on the bark, but that in masses, by natural exudation in consequence of a superabundance in the interior of the plant.

117. The conversion of starch through gummy matter into sugar is seen during germination, and it probably takes place in the floral structures also.

118. Sugar is decomposed by sulphuric acid, charcoal being deposited, and when acted upon by nitric acid produces oxalic and other acids.

Products composed of Oxygen, Hydrogen, and Carbon; the Hydrogen being in excess in relation to the Oxygen to form water.

119. *Wax*, best distinguished from the *oils* by its solidity and solubility in alcohol, is also a product of vegetation. In the tribe Myriceæ this substance is very common, the Gales or Dutch Myrtles yielding plenty of it.

In some parts of America, where tallow is scarce, the wax is annually collected from the Myrica cerifera, and made into candles. In the Ceroxylon andicola of Humboldt and Bonpland, it is secreted in abundance on the foliage, and what is called the *bloom* of many fruits and flowers is a sort of waxy exudation.

120. *Oil*, as a product of vegetable bodies, is of two kinds, fixed and volatile; the former require a temperature of 600° to decompose them, and are little affected by water and alcohol, the latter rise in vapour at 300°, and are soluble in alcohol.

121. The fixed oils are found in the cells of the tissue of a great many seeds, as the Walnut, hemp, castor oil, etc. In the ripe state, these seeds, according to Meyen, show no trace of fecula, but which is visible enough during the first period of the evolution of the embryo, and therefore we may conclude, that it has been converted to the fixed oil we find at an after period. In germination, this oil is converted into a saccharine mucilage, which nourishes the developing plant like the sugar in other cases; and, therefore, fixed oil may be looked upon, along with starch, gum, and sugar, as belonging to the nourishment of plants.

122. Though the seed and its coverings are the places in which fixed oil is mostly found, it is met with in other situations as well, and is found swimming in a fluid contained within cells, as in some Charas.

The following seeds in 100 parts of their weight, contain a proportion of oil as below:

Hazel-nut	60	Brassica napus Ol.	33
Garden-cress	56—58	Brass. præcox	30
Olive	50	Reseda luteola.	30
Walnut	50	Hemp	25
Poppy	47—50	Flax	24
Almond	46	Pinus sylvestris	22
Euphorbia lathyris	41	Sunflower	15
Brassica campestris Ol.	39	Grape-seeds	10—11

123. *Volatile Oils* are generally distributed over most portions of plants, being deposited pure in leaves, flowers,

and fruits; sometimes in cellules, in particular structures for themselves, and again in vesicles on the *surface* of the vegetable. In the Labiatæ, almost the whole of the plant is covered with these vesicles, whilst in Umbelliferæ they are found on the fruit in particular receptacles, called Vittæ.

124. The odours of plants are chiefly owing to these products and sometimes arise from their spontaneous exudation, but in other cases require the plant to be rubbed or broken. In fine sunny weather the oil is secreted in greater quantity, and of a stronger odour than in wet seasons.

125. These oils, (of which oil of Cloves, Cajeput, and Cinnamon may be taken as examples), contain two principles, Igreusine and Sereusine.

126. *Resin* is a term applied to many compound substances; when it is combined with oil it forms an *oleo resin*, when with Benzoic Acid a *balsam*, and when volatile oil and resin exist together in a viscid and strong-smelling state, *turpentine;* and there are intermediate states between resin and gum, called *gum-resins*. Resins combined with extractive matter and fecula, occur in the roots of many plants, as in the Ipomæa jalapa, which furnishes the Jalap of commerce.

127. *Caoutchouc* or Indian Rubber, is obtained by exudation, according to Meyen, for commercial purposes, chiefly from the Siphonia cahuca and Siphonia elastica, though many other plants yield it as well; when newly exuded it is of a whitish yellow colour, but becomes black on exposure to the air; it is insoluble in water and alcohol, but soluble in naptha and in some of the volatile oils, and likewise in a fluid termed *caoutchoucine*, obtained by distillation from itself. Scarcely any oxygen enters into its composition.

128. *Camphor*, as obtained by distillation from the Laurus camphora and Dryabalanops camphora, is of a white colour and crystalline texture, insoluble in water but soluble in alcohol, acetic acid, and the fixed and volatile oils. According to Proust, 100 per cent of

Camphor is obtained from the oils of Rosemary and Marjoram, $12\frac{1}{2}$ from Sage, and 25 from Lavender.

Products composed of Oxygen, Hydrogen, and Carbon; the Oxygen being in excess in relation to the Hydrogen to form water.

129. Under this head we can only mention a few of the acids of most common occurrence in the vegetable kingdom; further details of them, as well as of all the objects just noticed belonging more particularly to Organic Chemistry.

Acetic Acid	Destructive Distillation of Fibre.
Tartaric	Grape.
Oxalic	Wood Sorrel.
Malic	Currant.
Benzoic	Sweet-scented Vernal Grass.
Gallic	Oak or Gall-nuts.
Hydrocyanic	Bitter Almond.
Pectic	Carrot.
Lactucic	Lactuca Virosa.
Moroxylic	Bark of White Mulberry Tree.
Suberic	Cork.
Succinic	Amber.
Meconic	Morphia.
Kinic, Igasuric, etc., etc., etc.	

Certain products not included under the foregoing heads.

130. Besides the Alkalis Potassa, and Soda, and the Earths Lime, Alumina, Magnesia, and Silica, existing, more or less in plants, (though it may be doubted how far they are indebted to them by virtue of their own elaborative acts) are certain products termed *vegetable alkaloids;* these have a very bitter taste, which they sometimes lose in solution in water, but acquire

the peculiar narcotic smell of the plant from which they may have been taken. The great quantity of carbon and the presence of nitrogen, distinguish them amongst other characters from the substances already mentioned. Many of the plants, entering into our Materia Medica, possess an *alkaloid*, and it is in general upon this that their activity and power depend: in some as many as four or five have been supposed to have been found. The best known amongst them are

Morphia	In the Papaver somniferum.
Narceia	
Codeia	
Narcotine, etc., etc., etc.	
Strychnia	Strychnos nux vomica.
Brucia	
Atropia	Deadly Nightshade.
Hyoscyama	Henbane.
Veratria	Meadow Saffron.
Conia	Hemlock.
Emetina	Ipecacuhana.
Picrotoxia	Cocculus indicus
Daturia	Thorn Apple.
Quinia	Yellow Peruvian Bark.
Digitalia, Solania, etc., etc., etc.	

131. Under the head of Extractive Matter, a great number of substances are included, which form residues in analytical operations upon more compound vegetable products, but no general idea can well be given of them.

132. There are certain inorganic substances found within the cells of plants, composed chiefly of oxalate and phosphate of lime, and occuring in the shape of acicular crystals, either distinct from each other, or united into a compact fibrous bundle; and again, as Mr. Quekett expresses it, as small bodies composed of many crystals, which radiate from the same centre, thereby forming a more or less spherical mass: according to this gentleman the *four-sided prism* is most probably their ultimate figure.

133. These bodies are called *Raphides*, and occur in members of all divisions of the vegetable kingdom;

lutions of Acetate of Lead and Sulphate of Ammonia, whilst I made use of Sulphate of Iron and Ferro Cyanate of Potassa. In these experiments it will be seen that materials were employed which react upon each other in minute quantities; the plants impregnated with one or other of these substances, were placed together in a glass of pure water, but neither Unger nor myself ever saw a separation of the absorbed matter by the unhurt radicles, but which happened in my own experiments *as soon as they were cut*."

138. The last point we may notice, is that in many plants the excretion of water takes on a material form either in particular organs like the pitchers of Nepenthes, or Cephalotus, or at once upon different parts of the surface of the leaf; and it is stated that water has been known to fall as a *light rain* from the leaves of Poplars and Willows in shady places when the weather was hot and serene, and the same thing from Cæsalpinia pluviosa, has been observed in the Brazils.

COLOUR, TASTE, AND ODOUR.

139. *Colour*. The mode in which plants receive their colour is in three ways; the most general is that whilst the membrane of the structure is transparent, its cellules are filled with a colourless fluid in which the coloured globules are contained, which by shining through the membrane, give rise to the colour; the second, that whilst the membrane, is still transparent and colourless, the fluid contained in it is coloured; the third, and least common, is that the membrane itself is coloured.

140. It was soon remarked that the general colour of plants, green, was very much altered in its tint according to the degree of light to which the plants were subjected, that when they were grown in a somewhat dark place, they got paler, and if nearly all light was exclu-

ded, scarcely any colour was developed at all, such plants being called *etiolated.*

141. Under Digestion we have seen that it is only when exposed to the influence of light that the evolution of oxygen from the plant takes place, and that this ensues from its green-coloured portions; that a connection, therefore, between this and the presence of colour in a plant exists, was concluded, and from what we now know we are at liberty to say, as a general rule, that the presence of colour in a plant depends upon the action of light calling into play those vital actions by which the decomposition of carbonic acid is effected, and so causing the oxygen to be evolved, whilst the carbon remains behind; and that it is from this carbon undergoing certain changes, and producing a particular product, that colour has its origin, and in a ratio with the negation of light, so will be its deficiency.

142. But there are many circumstances well known that tend to modify this theory very materially. "The Fucus vitifolius," says Bonpland, "removed from a depth of 190 feet in the ocean, offers a curious phenomenon in vegetable physiology. Experiments made by divers render it probable that beyond a depth of ninety feet the penetration of light is very little, notwithstanding which this Fucus was of as fresh a green as the young leaves of our Vine or Grasses." Though the statement regarding the penetration of light is too limited in the above instance, there exist facts to show that a green colour may exist, and have been developed in complete darkness. Humboldt found some Grasses and a Wall Flower quite green in the subterranean galleries of the mines of Freyburg; and a Crocus that he himself planted there, produced green leaves, flowers, and anthers full of pollen. Besides, it must also be allowed that solar light may be dispensed with in the production of colour, and that artificial light is sufficient for it, though not for the evolution of oxygen from the coloured parts. Decandolle grew some plants in the light of six lamps, which he observed to become

green, but no appreciable quantity of oxygen was evolved; and Humboldt grew the Lepidium sativum in the light of a single lamp, and the green colour was developed. That colour is produced by the immediate influence of light upon the coloured part is untenable in such cases as follow. Wydler showed that in a sea-weed taken from a very considerable depth, its innermost parenchyma was of a green colour; the embryos of Rhamneæ and Malvàceæ are green; and the same colour is seen in the structures immediately surrounding the pith, etc., etc.; and further, our knowledge upon the subject is rendered more doubtful by the fact that certain plants which generally grow in the shade, and there produce a green colour, when exposed to more light evince a state of etiolation. Aspidium patens, etc., had their fronds quite pale on the spots upon which beams of light fell, whilst the other portions which were protected from them continued green.

143. That these and similar facts might be so resolved as to tally with the general rule before laid down, seems to me notwithstanding, highly probable, when we take into consideration that the various processes of nutrition are, as a general body, modified in different members of the vegetable kingdom, and that the amount of stimulus necessary to call into play the vital actions of these different members also varies; and moreover that we are equally deficient in a knowledge of many of the conditions under which respiration and the nutritive functions may and do take place, and with which a relationship in regard to the development of colour is sought to be established.

144. In respect to the chemical theory of colour in plants, several opinions exist; but we shall only notice the views of Macquart upon the subject.

145. The peculiar matter forming the green colour resulting from the modifications that carbon undergoes, and from whose various alterations all other colours in plants arise, is denominated *Chlorophyll*. This substance is soluble in the fixed and volatile oils, alcohol, and

ether; in a solution of carbonate of soda it becomes of a yellow colour, whilst concentrated sulphuric acid changes it to an intense blue.

146. According to Macquart, Chlorophyll furnishes a blue colouring matter by the addition of water, and a yellow on the subtraction of water. The blue colour, or *anthokyan,* is the primitive one in all blue, violet, red, brown, and orange colours seen in plants; it loses its colour by much exposure to the light, is turned green by alkalies, and red by acids, carbonic acid being sufficient for this purpose. The yellow colour, or *anthoxanthin,* is the base of all yellow colours, and is rendered blue by the action of sulphuric acid.

147. These two primitive colours in various states of power can exist in the same petal, though contained in different layers of cellules; the anthokyan being in the uppermost range, and the anthoxanthin in the lowermost cells; "by which means," says Macquart, "great variety is produced in some plants having coloured flowers."

148. Besides anthokyan and anthoxanthin it was found that in all white flowers there exists a yellowish white, or pure white substance, called by Macquart *flower resin,* and which he looks upon as a transitional state between chlorophyll and anthokyan, and considers that the white colour of plants must be regarded as a transitional state of green towards blue.

149. Various as are the differences between the colours of plants and their separate portions, they may be all more or less reduced to two separate series, at the head of which green is to be placed. The green either changes into yellow, this yellow into orange, and the orange into orange-red; or into blue, and this blue into violet, and the violet into violet-red. The fundamental tone in the one series being blue, and in the other yellow, and these two colours in the vegetable spectrum generating green.

Green.

Anhydrated Series.	Hydrated Series.
Blue Green.	Yellow Green.
Blue.	Yellow.
Violet Blue.	Orange Yellow.
Violet.	Orange.
Violet Red.	Orange Red.
Red.	Red.

150. A very remarkable transition of one colour into another is sometimes observed. Meyen saw the petals of the Tamarind white the first day and yellow the second; though not the beautiful yellow seen in the Compositæ. The Hibiscus mutabilis exhibits different tints according to the period of the day, the flowers are white in the morning, rose-red at noon, and dark-red at evening; but Saggra found that unless the temperature was above 66° Fah. they remained white all day. From some experiments made by Korthals upon this plant in the East Indies, he remarks, when speaking of their results, "These observations incline me to believe that the change of colour of Hibiscus mutabilis depends more upon a vital energy proper to the individual itself than to external agents." Oxygenation seems to produce a red *chromule* in the flowers, or rather causes the chromule, originally colourless, to pass into red.

151. Meyen saw upon the Cordilleras near Chili, several large shrubs of Colletia spinosa, having both red and white flowers, but the colours were confined to separate branches; Linnæus saw blue and white

flowers upon Polemonium cæruleum; and the circumstance of different coloured flowers existing upon the same plant is not now considered, as it was formerly, of very rare occurrence.

152. *Taste.* The sweetness, acidity, acridity, etc., of plants are derived from substances we have already mentioned, such as starch, sugar, acids, and resins; but whether any particular flavour is *pleasant or disagreeable*, will depend much upon the person perceiving it, though all may agree as to any plant having a powerful or only a weak flavour. In some the alkaloids have a very strong taste, as in Stychnia nux vomica. Assafœtida or Devil's Dung, Aloes, Quassia, etc., are other instances of powerful vegetable flavours. Some persons will be more apt to discover one particular flavour from another, though both may exist in the same plant, and the one they think predominates may be looked upon by other persons as existing in a less marked degree than the other which *they* will first notice. Some plants, however, obtain for themselves a universal disgust or dislike when once they have been employed. The twigs and stems of Glycyrrhiza glabra every child gets hold of and sucks as long as there is the least possible use in sucking; whilst at the mere mention of some of the Caladia in the West Indies fear will ensue. So acid is the Caladium seguinum, that when a small piece is chewed, it paralyses the muscles of the mouth, fauces, causes the tongue to swell, and deprives the sufferer of the faculty of speech; and occasionally, says Merat, the lips of the negroes are wetted with the Caladium arborescens as a punishment for slight misdemeanours.

153. *Odour.*—The odour of plants is intimately dependent upon the existence of essential oil; and the more strong and volatile these oils are, so is the odour more powerful and more easily elicited.

154. The odours given out by plants vary in intensity according to climate, many plants indigenous to Europe give out more powerful ones when growing in the tropics;

upon the other hand, some plants have been shown to lose them when vegetating in a warm atmosphere. Nocca says a Calendula lost its odour in a warm green-house; and Link observed the Marrubium vulgare to be odourless in Portugal.

155. Many plants will not afford their odour until bruised or broken; in others they are so volatile, that they are continually flying off from the plant. The Dictamnus fraxinella secretes an essential oil in great abundance; and in warm weather this exudes and volatilizes, so that the air becomes highly impregnated with it, and it is said that if a candle be brought near, the oily vapour will take fire.

156. The most curious circumstance connected with this subject, is a certain periodicity observed in some plants in regard to the evolution of their odour. Hesperis tristis is destitute of odour in the day, but is fragrant at night. Pelargonium triste evinces by day no trace of scent, but near sunset, and generally at a stated hour, it begins to be odorous. Cactus grandiflorus developes its delicious odour at the expansion of its flower, which takes place an hour after sunset; and Morren observed the odour evolved at intervals of half an hour.

157. According to Chevallier and Bouillay, a great number of odorous plants, both agreeable and disagreeable, exhale a considerable quantity of Ammoniacal gas.

158. It is a well-known physiological fact, says an author, that powerful odours often affect the nervous system strikingly, and hurtfully; even flowers of the most delightful odours do it when they are collected together in great number. The delicate scent of Lime trees when they are in a state of bloom, causes faintness and insensibility to those sleeping under them; and Violets have produced the like results in healthy females, when too many had been placed in the apartments they slept in. The influence of vegetable odours upon hysterical females is yet more striking; but in all such cases,

where pleasant odours operate so detrimentally, the nervous system is either considerably depressed, or in a state of much excitement.

159. It is quite otherwise, however, in regard to the odours of poisonous plants, especially the narcotic ones, the exhalation from which will produce the same effect as the internal use of the plant itself. This, it is true, has been ascribed to the odours themselves; but some of the plants acting most deleteriously in this manner are almost odourless. The noxious principle must be looked for in an evolution from the plant of its *characteristic property* which thus influences the system.

IRRITABILITY.

160. By the term Irritability, is most properly understood the proximate cause of certain phenomena seen to take place in plants, such as motion, both spontaneous and otherwise, and what is termed their sleep; the excitement of which is followed by such results as, did they occur in connection with an animal organization, would often be considered as evidences of a power of volition in the body in which they were seen to happen, or at least of the existence of a nervous system.

161. The evidences generally received as indicative of the presence of irritability, may be divided into two classes: 1st, Certain actions resulting from the excitement of external causes. 2nd, actions seeming to have their origin and excitement within the plant in which they occur.

162. Under the first division may be included what is termed the sleep of plants, though we are perhaps far from right, if we consider this phenomenon to depend solely upon external agents as influencing the plant; though what may be the other conditions we are completely ignorant of. The negation or presence of light in

bringing about the phenomena to be mentioned, no doubt is considerable; and an original tendency to a periodicity of action, the excitement to which has been originally impressed upon the plant, also may prevail; but that these are accompanied or modified by some powers inscrutable to us, is just as apparent. In what we have to mention, a few only of the many facts known upon this subject, can here be noticed.

163. At certain hours, most generally when the light comes to be moderated, and the dews of the evening begin to be deposited, plants, whose leaves and flowers have been erect and expanded during the day, begin to droop, the leaflets of the compound leaves incline toward each other, and the general petiole is lax and somewhat recurved, the flower may droop a little, and its petals close one upon the other; after the expiration of a certain time, and towards the morning the leaves and flowers gradually become erect and unfold, and burst out again in all the freshness and beauty which can mark them, at this their most fragrant and lovely period.

164. This phenomenon, however, in all its relations is subject to innumerable modifications; in some cases instead of a dormant state being induced by the negation of light, a most active state of vital energy arises, and plants burst out in all their beauty of flower and deliciousness of scent.

165. The younger the plant, the more evident the nocturnal position of the leaves ; as a general rule their daily position changes with the sinking sun, but more depends upon the action of the solar light, than the actual position of the sun above the horizon, because in dark weather, or when the sun is obscured by a thick cloud, the leaves often shut, or even never open again the same day, when this state continues for some time. It was noticed, that on one of the cold days experienced in Germany in July 1838, the larger leaves of the Hedysarum sank at 3 o'clock p. m. clothing the stem

like a mantle, immediately after the overcloudng of the whole horizon. It then rained the whole time until late at night, and the plant remained in its true nocturnal condition until the following morning. Some Mimosæ closed their leaves the same day at a quarter past five, and Morren observed, that during the annular eclipse which occurred in 1836, the leaves of many irritable plants closed almost completely together.

166. Decandolle found that he could bring about the nocturnal conditions of the leaves of some plants in the day-time, and the diurnal conditions at night, by alternate exposure of the plants to the influence of the light of Argand lamps, but that in other cases he could not.

167. The times at which flowers close in the evening, are various in different species, and also at certain times of the year. The Daisy is said to close in summer at 5 P.M., in spring at 3 P.M. A *regular* closing and opening at certain hours, is to be seen only in young flowers; some flowers, after closing in the evening, will not open again at their accustomed time, if the sun does not shine, and especially if it is cold and rainy.

168. Some plants open their petals or *produce* their flowers only at night, which, by morning, wither away. The flower of Cereus grandiflorus begins to expand at about 6 or 7 P.M., is fully blown at midnight, and ceases to flourish towards 3 or 4 A.M.; other plants shut their flowers before an impending storm, and others close them whilst the sun is shining upon them.

169. Under this head are also to be classed those motions induced in the Sensitive plant, and Venus's Fly-trap, etc., by the contact of external agents; the Sensitive plant requires a temperature of 77° Fah., and plenty of moisture, in order to exist in a very irritable state, and which is said to be so considerable in its native country, that heavy walking over the ground in the neighbourhood, is often sufficient to cause a closure of its leaves.

170. Of those under the third head, we may notice the

peculiar motion seen in Hedysarum gyrans, which is not occasioned by any touch or movement of the air, as in Mimosa, Oxalis, Dionæa, etc.; no sooner, says Linnæus, had this plant acquired its ternate leaves, than they began to be in motion in every direction; this movement did not cease during the whole course of their vegetation; nor were they observant of any order, time, or direction, one leaflet frequently revolved whilst the other on the same petiole was quiescent; sometimes a few leaflets only were in motion, then almost all of them would be in movement at once; the whole plant was very seldom agitated, and that only during the first year. It continued to move in the stove during the second year of its growth, and was not at rest even in the winter. The irritability of this plant, says Burnett, is never so great even in our best hot-houses as it is said to be in its native climate, and its motions are very seldom so lively as those described by Linnæus; warmth appears essential, for they are always most observable when the heat is greatest. That they are not attributable to the sun's rays, or to any currents of air, is shown from the fact that the plant loves the shade, and that the motion is most evident when the stove is closed, and the atmosphere quite still.

171. Not a few instances are to be met with in the lowest tribe of plants, as in certain Algæ, in which motion decidedly spontaneous is to be seen, and which has given rise to doubts as to whether these beings were really plants or animals, and which, accompanied as they are by other phenomena which hold no analogy to what is seen in the higher orders of either kingdoms, have rendered the exact situation of them in the scale of created objects a doubtful point, at least with those who would place definite limits between the animal and vegetable kingdoms; these, however, we shall pass over, and notice another subject.

172. When speaking of germination and the evolution of the radicle and plumula, we remarked the general and powerful tendency of the former to direct itself

downwards or beneath the earth, and the latter upwards or above it. Other instances of the disposition of different parts of a plant to direct, turn, or twist themselves in particular directions, are not wanting, and presiding over which a ruling principle is seen which is independent of any *external* exciting cause.

173. The tendency of the stem towards light is well known. Potatoes which have been lying in dark cellars during the summer often bud out their stems, and immediately direct them towards a hole or crevice through which a little light may be entering, and will continue to advance towards it until they attain the particular spot. Potatoes have been seen with such stems twenty feet long.

174. Du Trochet remarks that there are some plants like the common Hop and large Convolvulus which endeavour to avoid the light. He placed stems of these two plants in a glass vessel of water close to a small window, the tops of the stems were placed against the window in the morning, but during the course of the day they turned away from it, but in the night came back to their original position. The disposition of plants to twine only in a certain course, and the almost impossibility of preventing them doing so, may be also remembered.

175. It would require more space and time than can be here devoted to enter into this interesting subject further than we have done, and to endeavour to prove from facts well known to exist amongst the phenomena of vegetable organization, that the existence of some power of volition, however low that may be, or if you will, *something superadded* to the material structure, of which we have evidences totally distinct from those generally received as proofs of anything else except a nervous power, is not an opinion that should be passed over with complete disregard, or that is incompatible with the modes of our reasoning upon the phenomena of other organized bodies. As it is we shall conclude with the following remarks from Meyen's observations upon Mar-

tius; first reminding the student, in the words of an eloquent writer of our own country, (substituting plants for animals) "That if to this mode of reasoning it is objected that it would go to establish an immaterial principle in vegetable beings, I have only to answer, Be it so. There are in some plants phenomena, with regard to which we contend, that they are entirely distinct from anything we know as the properties of matter." "One of the most truly philosophical botanists of our own time, Von Martius, has endeavoured to prove the connection of a mental principle with the body of plants, but which with the great mass of botanists will scarcely find acceptance, but in truth he has not gone too far, for as he himself remarks, the animal form sinks so low, as to have extinguished all qualities of animal life, and to exhibit on the other hand, the expressions of vegetable existence; and as if returning again; phenomena are to be seen in the more highly developed plants which belong to animal organization. Animal and vegetable life seem by no means to be sharply divided from each other, for we cannot, in every case, certify a mind to the one, or deny it to the other. The mind of plants is far simpler than that of animals, or can only be compared with that of the lowest of the scale. We figure to ourselves the mind, or psychological principles of the Planariæ, Polypi, Ifusoria, etc., and the existence of which we have no positive reason for denying; and if we call to mind the intelligent animating principle of a Sensitive plant or of an Oscillatoria, we shall find the belief of the existence of a mental principle in plants no longer a laughable hypothesis. If we regard the plastic conditions of the fertilization of plants, we shall find that the descent of the *pollen-tube*, along the canal of the style, its course through the cavity of the ovarium, and its entrance through the opening of the coats of the ovule into the interior of the nucleus itself, are movements more complicated, and, if we may so express ourselves, more intellectual than the movements of many lower animals, at least the formative

process of the eggs in the true Infusoria, and some other animals is carried on in a far simpler manner. As the life of plants chiefly exhibits itself plastically in operation, the intimations of a pyschological principle are but slight, and only seen in connection with the phenomena of nutrition, or that evident power which presides over the plant, and places in their true combinations and conditions those materials, giving to it form, and upon which the activity of every organ is but conditional. This power in a few cases only is seen in such a state of development and perfection, that its intimations can be placed alongside the intimations of the sensitive life of animals, nevertheless the intimations of design or aim, and even the development of means to attain designs or aims, is evinced pretty generally in connection with vegetable life, and these might alone be sufficient to show us, that we have still to place the plant somewhat nearer to the animal than we have hitherto done.

GROWTH AND PROPAGATION.

176. When speaking of stems under the anatomy of plants, we divided them into Dicotyledonous or Exogenous, Monocotyledonous or Endogenous, and Acotyledonous stems; we have now to inquire into the manner in which they increase in size, and whether they differ in this respect from each other.

177. We have mentioned that in a section of an Exogenous stem there is visible a central system composed only of cellular tissue, called pith; next to this, and enveloping it as it were in a case, is the medullary sheath composed of spiral vessels; following which are layers of woody matter formed of fibre and vascular tissue; and, lastly, the bark; and that there run layers of cellular tissue from the centre of the stem to its circumference, called the medullary rays.

178. Now although this is the general disposition of parts in such a stem, instances are to be met with in

which Dicotyledonous plants exhibit remarkable exceptions.

179. Woody fibre is to be found in the pith of Mirabilis, and spiral vessels in that of Nepenthes; and in the latter stem there are no concentric woody layers, nor medullary rays, and spiral vessels occur close to the modified bark. In the Peppers which are not arborescent, the wood exists as scattered or separate bundles of tissue for the whole period of life of the plant, whilst in those arborescent, according to Meyen, during the second year of growth a complete ring of wood is formed at the circumference of the stem, but within which the wood exists as separate bundles as before: and we are much indebted to Dr. Lindley for making known several remarkable cases in which there is the most curious departure from the normal appearance of the Exogenous stem; but in regard to these, as well as to all cases of *abnormal* development, the remark of that author should be carefully remembered, that "the part next the centre is but little affected," and "that the presence of a central pith, and a greater degree of hardness in the wood next the centre than in the circumference," are the signs from which we may conclude an Exogenous growth.

180. The increase of size in an Exogenous stem takes place by the deposition of a new zone of wood on the *outside* of the one last formed, and therefore it is said to grow from without, or to be *Exogenous*.

181. Now what is the origin of the woody layer by means of which the increase of growth takes place? We must confess that at the present moment this question is unsettled, for valid objections appear to exist against what must be considered as even the most probable views of the subject. We shall notice these only, and the objections they are open to. If we examine the stem of a plant in spring, we shall find between the bark and the wood a layer of viscid matter called by Du Hamel, *cambium*, and *reproductive layer*

(couche regeneratrice), by Mirbel; from this cambium is supposed to be derived the wood.

182. The cambium is by some supposed to be deposited by both the old wood and bark; by others, again, only by the bark, and that it descends gradually from above downwards, just as we know the wood is deposited from the leaves towards the root. The reasons that may be adduced in favour of the secretion of this matter by the bark, are the following:—In the bark of some trees, especially that of the Beech, are often to be seen little nodules which cause a projection of the bark externally; these bodies have been particularly observed by Du Trochet, who gives them the name of *embryo-buds;* he considers them to have their origin in the parenchymatous tissue of the bark: they have a bark of their own, but which is united to that of the tree, which, in some cases, may be distinguished by the direction of its fibres; as they continue to increase a series of concentric woody layers are deposited in them around a central cellular system or pith, they have medullary rays, and in fact an appearance and nature of an Exogenous stem; by degrees the wood of the embryo-bud comes into contact with that of the parent tree, the bark of the bud being absorbed at the point where these meet. In the Cedar of Lebanon, branches have been seen proceeding from the summit of these embryo-buds.

183. According to Du Trochet, the buds in spring have plenty of cambium, and as woody matter has been deposited only in connection with the bark, for these buds have no connection at first with the old wood of the tree, so the cambium must be looked upon as proceeding from that structure. And further, that it not only proceeds from the bark, but likewise is deposited from above downwards, is supposed, by Meyen, to be proved by the following circumstances.

184. If in spring, when the buds have just burst, we make two circular cuts, one a short distance from the

other, round a stem or branch, and remove the ring-like piece of bark between them, at the same time clearing the exposed surface of the wood which will be thus left bare, so that no portion of the internal layer of the bark shall be left upon it, we shall find that by the expiration of summer the end or surface of the upper cut is very much swollen, whilst that of the lower is scarcely enlarged at all. If the branch is now cut across between them and examined, above the upper cut we shall find a deposition of woody matter; beneath the lower one, no such deposit will be seen; which is also the case in regard to the surface of the wood which was exposed.

185. Leaving these considerations for a moment, we may remark that the essence of the theory we are here intending to illustrate is, that the new woody matter is derived from the *cambium*, and that this matter has its origin in the formative juices descending from the leaves towards the root. The objections to this will be spoken of afterwards.

186. In 1809, Du Petit Thouars, in an "Essay on the growth and diameter of the trunks of Dicotyledonous trees, &c.," proposed a theory upon the origin of wood, which has many supporters, and which, according to them, is the only one that can explain the formation of this structure throughout much of the vegetable kingdom.

187. This theory is that buds upon a tree are not materially different from the seed of a plant, and that like them they can evolve roots or radicles; these are developed from the base of each bud, and proceed downwards with considerable rapidity between the bark and the wood, and connect themselves with the roots of the buds below them. These roots are nothing less than the fibres out of which the woody layer is afterwards formed, and which are nourished by the cambium or formative juice from the bark.

188. Supported as this view of Du Petit Thouars is by many circumstances, it fails elsewhere. If a scion is

taken from a tree with white wood, and placed upon a stock whose wood is red, in the course of proper time a new woody layer arises, which, so far as the bark of the scion goes, exhibits the colour of the scion's wood, but below this shows the colour of the stock; now were the fibres from which the new wood is formed the roots from the buds above, the wood ought to have the same colour all the way down from the scion from whose buds it would be produced; but it is not so coloured, and therefore it could not have been generated by the buds above.

189. Dr. Lindley, however, discussing this subject, says, in regard to similar facts: "They are true; but do not warrant the conclusion which have been drawn from them. One most important point is overlooked by those who employ such arguments, namely, that in all plants there are two distinct simultaneous systems of growth, the cellular and the fibro-vascular, of which the former is horizontal, and the latter vertical. The cellular gives origin to the pith, the medullary rays, etc. The character of wood is chiefly owing to the colour, quantity, size, and distortions of the medullary rays which belong to the horizontal system,"——"as the medullary rays develope in a horizontal direction only, when two trees in which they are different, are grafted or budded together, the wood of the stock will continue to preserve its own peculiarity of grain, notwithstanding its being formed by the woody matter sent down by the scion; for it is the horizontal development that gives its character to the 'grain of wood,' and not the perpendicular pleurenchyma encased in it." Notwithstanding this a dissentient from the views of Du Petit Thouars may say that the colouring matter in the Diospyros ebenum Retz, is to be found within the fibre of the wood itself, and though it is true, only in the short pleurenchyma its origin is sufficiently shown, and that this is also the case with Coesalpinia brasiliensis, Coesalpinia tapan, and others; and "in Tiger-wood the long cells of the wood have their membrane somewhat

coloured, and are filled inside with a yellowish brown matter, and the walls of the cells of the spiral vessels are thick throughout, and the interior of them filled with a brownish colouring matter," so that, as has been remarked, "anatomical investigations show that in coloured wood the fibre itself shows also a like colour, and the tint of the wood is not alone to be ascribed to the medullary rays." (Meyen.)

190. The existence of the embryo-buds already spoken of, in which concentric layers of woody matter are seen, and which are generated in the bark, militate strongly against the theory of Du Petit Thouars, and this coupled with a peculiar development of vascular structure, according to M. Decaisne, to be seen in the Beet-root, are considered by Dr. Lindley to be the greatest objections to the views under consideration.

191. Returning to the former part of this subject, we may now mention the objection to the theory that new wood is formed from out of cambium. "In many Exogens of tropical countries, wood is not deposited in regular circles all round the axis, but only on one side of the stem or along certain lines upon it; were it a deposit from the bark, or a metamorphosis of cambium, it would necessarily be deposited with some kind of uniformity. In Endogenous trees there is no cambium, and yet wood is formed in abundance, and in the centre, not in the circumference, so that bark can have in such cases nothing to do with the creation of wood. (Lindley.)

192. In regard to these objections we can only allow that the last-mentioned one that Endogenous plants have no cambium, and yet have wood, militate against this view of the question; but even here if we allow, and which we at present must do, a complete difference as regards the disposition, arrangement, and relationship to each other of the elementary structures in Exogenous and Endogenous stems, may we not also believe that such difference only exists as dependent upon a particular way in which these structures have their origin, and

which may vary in the two stems, and that there is no more necessity that they should be produced in the same manner than that they should be disposed in the same manner.

193. In respect to the want of uniformity in the woody layers of trees of tropical countries, we may remark that the theory of Du Petit Thouars is on a level with the other in regard to an explanation, for if by the one it is made to depend upon a greater development of buds on certain sides of the tree than on others, and therefore in those places a greater transmission of roots downwards from their bases, so by the other it may depend upon a greater transmission of formative juices downwards in the bark, instead of fibres free from it.

194. But it must be candidly allowed that the circumstances adduced as proof of wood not being formed in those cases in which rings of bark have been removed from a stem is owing to an interruption of descending juices through the bark, might be looked upon as equally corroborative of an interruption of descending fibres from the buds being the cause. The wood when first deposited is of a yellowish white colour, and receives the name of Alburnum; as it gets older it has a more decided colour, and becomes harder, and towards the centre of the plant is called Duramen, or heart wood.

195. Malpighi seems to have been the first who stated that the number of zones of wood seen in a plant was equal to that of the years it had lived.

196. This mode of reasoning is now known to be open to much fallacy. In our own climate, and other temperate and cold ones, where we are aware that the deposition of one zone of wood takes place annually, and only one, we may come near the mark; but even in France it was found by Adanson that some Elms which were known to have been planted for 100 years in the Champs Elysées, varied in the number of their zones in different specimens from 94 to 100; but which has been explained away by supposing that when planted they were not all of the same age.

197. In those tropical countries in which the wet and dry seasons are well marked from each other, so will be the periods of vegetable vigour, and the separation between the zones of wood be easily seen, but in others in which these seasons are not so well marked, neither will be the periods before mentioned, and one zone of wood will be found running into the other so that no line of demarcation can be seen. It has likewise been said that in certain tropical situations where the atmosphere and earth are constantly moist during the whole year, two periods of vegetation are known, and a harvest takes place in summer and in winter, and that there two zones of wood will be annually deposited in plants. In the Island of Luçon Meyen saw, as he supposed, evidences of such a supposition. Decaisne has said that each zone of wood in Menispermaceæ is the growth of several years. Again, the zones are not always concentric to the pith; in plants of southern countries the eccentricity is greatest, especially in those of damp situations. In some cases the amount of eccentricity is so great that the divergent portion of the zone ceases to have the pith within its circumference.

198. The origin of the Medullary rays which traverse the woody layer, must be looked for at the first period of the growth of the stem; they are formed out of the parenchymatous cellular tissue, which is placed between the pith and bark of the young plant, and which from the separation of these two from each other by the deposit of woody matter between them is extended, and flattened into radiating plates.

199. Kieser and Meyen make two sort of medullary rays; the large ones or those running from the pith to the bark; and small ones found in many stems, and not keeping up a connection through the centre to circumference, but limited in their extent.

200 Besides a growth connected with the woody layers of plants, there is likewise one of the bark to be observed, but here the new matter instead of being de-

picted on the outside of the old is placed on its face towards the centre.

201. When we examine the liber of a stem, we shall find it composed of a number of very fine concentric layers, generally separable from each other, and varying in number according to the age of the plant; these layers are the several depositions of new matter which have been generated during the growth of the plant. Malpighi found, that in one Chesnut tree, two librous layers had been formed during the year, but he discovered afterwards in a branch two years old, six layers. Mirbel observes, that in the Elm and Lime tree, four layers are generated every year. Treviranus thinks, that in a great number of cases, each zone of wood is represented by two layers of liber; but as a general rule no definite conclusions have been arrived at upon the subject.

202. The Epidermis, which covers the stems of young plants, remains sometimes only for a very short time in a whole condition, but cracks or peels off; in other cases it will remain for three or five years, when, unable to bear any longer the extension of the bark beneath, it begins to show fissures.

203. In different plants the various layers composing the bark increase in a greater or less ratio with regard to each other; thus, according to Mohl, in Banksia and Hakea oleifolia, the enlargement of bark is most dependent upon increase of the stratum parenchymatorum; in Acer campestre upon that of the stratum suberosum and librosum; and in Quercus suber upon that of the stratum suberosum.

204. The developement of Cork (the stratum subersum) in the Quercus suber or Cork Oak, generally commences in the third or fourth year of the growth of the plant; and it is said, always at the lenticular glands, from which it spreads itself over the rest of the plant, but dies soon after its development. In the Birch a corky generation begins at the eighth year, but unlike that of the Cork-tree, it keeps fresh for several years,

yields to the extension of the stem, and exfoliates but slowly.

205. In regard to the separation of plates or scales from the bark of plants, Mohl observes, (speaking of the Genus Prunus more especially,) that the external coat of the bark remains smooth for some time in consequence of a formation of new layers upon its internal surface, and a gentle exfoliation at its external one, and acquires at the same time a sensible thickness (Prunus domestica), but in the end tears off as in the Birch, and the surface of the stem becomes rough and scaly; but the scales are not as in the Birch, the result of a new development of parenchymatous matter *external* to the stratum parenchymatosum, but have their origin at an expense of the parenchymatous layer itself, and librous one as well; but Physiologists have been wrong in supposing, that the scales are the result of a mere desiccation and simple exfoliation of the bark; the layers of the bark forming the scales are separated by thin layers of new tissue developed in the third or fourth stratum of the bark, before they become completely detached; the separation of each portion being thus as it were prepared. In Prunus, a series of superimposed scales are found, which separate at first by their edges, but remaining for some time fixed upon the stem, whilst in the Plane-tree the scales fall as they form.

206. We shall now turn to the Endogenous stem, and we shall find that on examining one, and comparing it with that of an Exogenous plant great differences in appearance present themselves.

207. In an Endogenous stem no true central cellular system or *pith* is to be seen, the nearest approach is to be met with in Palms, in which the cells of the general cellular tissue continue pretty large in the centre of the plant, and are often filled with amylaceous matter; but even through this part bundles of woody fibre and vascular tissue run along, and no separation of the cellular mass from the rest of the stem is to be observed.

208. The woody matter is arranged as bundles of

fibrous and vascular tissue running down the stem, and is imbedded in the general cellular substance, each bundle keeping distinct from its neighbour, and no continuity of them exists, so as to give rise to the compact uniform layers seen in Exogens, however close the fibres may happen to be, as in the Palms.

209. No medullary rays similar to those of Exogens, and no true bark enveloping the whole structure of the stem is to be found.

210. Close relationships have been endeavoured to be established by some between the Endogenous and Exogenous stem, medullary rays have been said to exist in the Aloe; and the rhizoma of a Tamus, according to Du Trochet and Mohl grows like an Exogen, whilst the ascending stem preserves the organization of an Endogen; and, says Mohl, speaking of the Rhizomæ of Tamus elephantes, and T. communis, "there is a central parenchymatous body abundantly filled with amylaceous matter, in which run but few vascular bundles, and a parenchymatous *bark* formed exteriorly of a thin layer of *corky cellules*." M. Decaisne has shown, that a great number of Exogenous plants are completely destitute of liber in certain parts, and Phytolacca dioica in the whole of its stem, and as the liber is always wanting in Endogens, so an analogy is supposed to be established; and finally, according to Mohl, the stems of Endogens and Exogens are the same during the first year of their growth.

211. In respect to these and similar facts, which do not admit of discussion in an elementary work, we may use the words of Steinheil, "That without doubt a new course has been opened to observation, and there are a series of facts yet incomplete, which require to be connected by some general formula;" but at present we must believe, that Endogenous and Exogenous stems are distinct from each other.

212. According to the famous hypothesis of Des Fontaines, the increase of size of the Endogenous stem takes place thus: At the centre of the stem, formed at

first by the union of the bases of the leaves, bundles of fibres are generated; more bundles continuing to be formed, then push away those formed before them, and gradually press them towards the circumference, this central generation, and pressure towards the circumference going on, causes the latter to become so hard, that at last it will not yield to any more pressure; increase of diameter therefore ceases, though that of length continues: and thus from the stem growing from within, the new matter pushing the old outwards, it receives its name of *Endogenous*.

213. It is now satisfactorily proved, however, that the manner of growth is somewhat different from that mentioned above, and the term Endogenous is not so applicable as was formerly supposed.

214. The younger Moldenhauer, several years after the announcement of the views of Des Fontaines, which took place in 1796, stated, that the woody fibres proceeding from the bases of Palm leaves, dived so much more towards the centre of the stem, the older the leaves were, so that the inner bundles of wood were to be looked upon as belonging to the oldest leaves, just the reverse of the theory of Des Fontaines. Latterly the researches of Mohl upon Palm trees, brought to Europe by Martius, and those of Decandolle, Meyen, and others, have proved, that the youngest formed bundles of woody matter lie in the centre of the stem at first, but as they run down it diverge to its circumference, so that the bundles do not lie parellel with each other, but that there is a continual crossing of the inner over the outer ones; and that, therefore, from observations upon woody Endogens, the following seems to be their mode of growth.

215. The new leaves at the top of the stem develop fibrous roots or woody bundles, which pierce downwards along the axis towards the centre, in which they continue to run for a certain distance, and then diverge out towards the circumference, having attained which, they keep running down in a parallel direction

by which means the stem becomes much harder at the base than elsewhere.

216. In the Grasses the stem is hollow, having a diaphragm or partition at the various nodi; the vacuities arise from the inability of the centre of the stem (originally solid) to keep up with the increased growth, and the consequent quick extension of the circumference from it.

217. Of the Acotyledonous stem, the only example we shall choose will be that of an aborescent Fern. The stems of these plants vary in appearance according to the species, and to give a general view of them is rather a difficult matter; but they all show separate bundles of woody matter like the Endogenous stem, and these bundles are arranged in a circular manner near the circumference of the axis. The bundles themselves may be round, elliptical, irregular, or sinuous, and contain in the centre spiral vessels, or modifications of reticulated ducts. A cellular parenchymatous tissue generally occupies the centre of the stem, which, when fresh contains much fluid and large grains of amylaceous matter. The external covering of the stem, or bark, if we may so term it, according to Mohl, is composed of two layers, which gradually run together so as to form only one. The growth of these stems takes place by development of matter from the terminal leaves, the wood being formed of the converted bases of their petioles.

218. Mohl traces a relationship between these stems and those of Cycas, Treviranus with the Coniferæ, and Link and Meyen with the Endogenæ.

GENERATION.

219. The last function we have to speak of under the physiology of plants, is at the present moment a completely unsettled question, in regard to many of its relationships, on account of the diversity of opinion enter-

tained by some of the first botanists concerning its true nature, and the very opposite views taken by them of certain of its phenomena, seemingly substantiated by existing facts; and the student must be warned that decisive conclusions upon many points connected with it, are just now totally out of the question. What follows we shall class under separate divisions, so that the notions generally held upon the subject, and which are of older occupancy, shall not be confounded with those of less general acceptation and of younger birth; but all of which are equally necessary to be regarded even in a work essentially elementary.

First Division.

220. During a certain period of the life of the plant, we find within that part of the pistil called the ovarium, the body termed the *ovule*, and that at an after period this ovule has become transformed into a seed, and is contained within the altered ovarium or *pericarp*.

221. If the *ovule* had been removed and placed under the conditions of germination, we should have found that it would have remained an inert mass as far as regard the results which should follow these conditions; but when in its altered state as *seed*, it is subjected to the like circumstances, the evolution of another being like that in which it had its origin is seen to take place.

222. Now we say this transformation of the ovule into the seed is the result of *impregnation*, *fertilization*, or *fecundation*, and that without this having taken place, the ovule never could have been changed into a seed, nor have produced another being, and that the process essentially consists in the *pollen*, which is contained within the anther coming somehow or other into contact with the *stigma*, or absorbing surfaces of the pistil, and then transmitting some *vivifying influence* into the *ovule*, by which it is *impregnated*, or the perfection of it into seed takes place: that the *vivifying influence* and

the *germ* to be vivified have their origin in *separate* organs; that the *former* is to be looked for as connected with the *stamen*, the *latter* with the *pistil*, and finally that we have therefore *sexes* in plants, the stamens of which may be held analagous to the generative organs of *male* animals, the pistilla, to those of *females*.

223. To trace how far back the knowledge of different sexes in plants existed, and to prove how early the particular structures representing each sex were known, is not our place here; but we may remark that Theophrastus speaks of bringing the *male* Date in contact with the *female* one, in order to procure fruit; and that Zaluziansky in 1604, (if not in 1592,) says that most plants are hermaphrodite, for they show both male and female generative organs. The circumstances too which have inclined the world towards a belief in the existence of distinct sexes in vegetables may be passed over, assuming for the present, that such is really the case.

224. The act of *fecundation* ensues in most cases, whilst the flowers of the plant are in greatest beauty, and begins with a degree of rising of the anther, accompanied by a dispersion of pollen; in some plants it is accompanied by the evolution of heat and a strong odour; the first being especially seen in the Aroideæ, but this rising of the anther and dispersion of pollen, may take place at later or earlier periods, even as soon as the flower opens, and in some cases in the closed flower.

225. In the greater number of cases, damp and rainy weather is detrimental to the plastic process of impregnation; and we know several *submerged plants* whose flowers rise to the surface of the water, to await this process; but on the other hand, we know plants in which it takes place beneath its surface.

226. It is doubtful how far very high temperature is injurious to the performance of impregnation, though said to be so in some works upon the subject; for Meyen saw the most luxuriant vegetation upon the coast of Southern China, whilst for months the temperature was nearly 100° Fah.

227. The *diffusion of the pollen* upon the surface of the stigma takes place most quickly after the dehiscence of the anther, of course in those cases in which the flowers are Hermaphrodite, and the anthers placed near to or on a level with the stigma; on the other hand, when the plant is Monæcious or Diæcious, and even in Hermaphrodite flowers, when the position of the sexual organs is not as we before stated, a more or less lengthened period must ensue; and not only this, but often some intermediate means, independent of the plant, must exist, by which it may be effected.

228. These are generally *insects* and *wind*, the *former* flying about from flower to flower in search of nourishment, and attracted by the saccharine matter found in many floral structures, in their endeavours to obtain it rub their bodies against the anther, and thus carry off with them in their flight the pollen, which by their afterwards alighting upon a female flower is enabled to fulfil its purpose. The *wind* disperses pollen in the air, which at length falls upon different objects, and amongst them the *female* flowers of plants; the *Sulphur rain*, as it is termed, being nothing more or less than quantities of the pollen of Pinus sylvestris, carried about in the air and afteward deposited.

229. In many plants the stamen, at the time the anther bursts, and the pollen should be evacuated, *moves toward the stigma*. In other cases the stigma *moves to the stamen*, and again *both may approach toward each other*, in order that the necessary contact may be effected. All such cases afford examples of *irritability*.

230. The pollen being fixed upon the stigma, the next thing that takes place is the *protrusion of the pollen-tube*. In general only one tube protrudes from each grain of pollen, though in some cases, it is said, that several may be seen; as the protrusion of the tube goes on, it pierces through the stigma, and proceeds downwards to the ovarium through the interior of the style; as it runs down the style, its course is mostly pretty

straight and direct, though sometimes it twists and turns about very remarkably.

231. In this passage of the pollen-tube downwards from the stigma, the object of it has been to come into contact with the *ovule;* this the end of the tube at length meets with, and having done so it enters it by the *foramen;* and this being accomplished, it pierces the point of the *nucleus*.

232. The *nucleus*, in most plants, is a conical body formed of a mass of cellular tissue, whilst in some it appears as a hollow cellular skin or case.

233. When the *nucleus* is composed of *a solid mass of tissue*, about the time when the pollen comes into contact with the stigma—that is as a general rule—a vacuity or hollow appears within it at some little distance from its upper end. This enlarges, proceeding downwards along the axis of the nucleus, whose tissue gradually more or less disappears, a new membrane is formed, which now encloses the enlarged hollow, and we have formed the *sac of the embryo*, or *quintine* of some writers.

234. In most cases the *sac of the embryo* is completely developed by the time the pollen-tube pierces the nucleus, at least at its upper or *micropyle* end and which is the part coming into contact with the tube which is entering; but sometimes the sac is not begun to be formed until the pollen-tube has already reached the nucleus.

235. The *pollen-tube*, having entered the ovule by the foramen, and pierced the nucleus at it upper part, comes in contact with the sac of the embryo; at the upper part of this sac, according to Brongniart, a *transparent little bladder*, containing minute granules, is then to be seen, which is open at one point, and seems to have had its origin in a pressing inwards of the membrane of the sac of the embryo. In this bladder, after a time, a cellular mass is formed, and our present knowledge (says Meyen) upon this subject satisfies us, that this bladder

is the first formation in the process of generation; but *the origin of which is to be looked for in the material or dynamic influence of the pollen-tube, (the development taking place in the interior of the ovule, and within the sac of the embryo,) and by no pressing in of its membrane.*

236. After a little time this bladder is extended in the form of a thread, or *suspensor,* as it is by some termed, having a larger and swollen cell at its lower end, and then, and not before, is the *future embryo* to be seen within this swollen end of the suspensor.

237. In those cases, in which the *nucleus* already exists as a *hollow case,* the plastic process is a little different, the pollen-tube having entered the ovule by the foramen, pierces the end of the nucleus as before, but descends at once into the interior of it, at the end of which, after a certain change, the little bladder is formed, and which presents the same modifications as mentioned before, in regard to the suspensor and embryo.

238. *In no case whatever* is the *young embryo* to be looked upon as produced directly by the *end of the pollen-tube,* and therefore a product, originally of the stamen; but as arising *within the nucleus,* on account of certain influences conveyed there by the pollen-tube, and, therefore, is a *product of the pistil.*

239. The difficulty of knowing what takes place at the union of the end of the pollen-tube with the upper end of the embryo sac, can only be met by the ignorance we are in of a somewhat analagous process in the animal body.

Second Division.

240. Without stopping to notice the opinions of Spallanzani, Smellie, and some others, who have denied the existence of sexes in Plants, we shall state the views of some eminent living German botanists, upon the subject of generation, and which at the present mo-

ment cannot be denied, as possessing claims to the attention of every one, both on account of the authority which the names of their highly reputed authors convey, and the most evident foundation in facts, according to them, from which their opinions are derived, as shown by the microscopical observance of the minute structure of the plants which they have examined.

241. According to Schleiden, a cellule in the interior of the nucleus, at *first* differing in no way from the other cellules, developes itself in a disproportionate manner soon after the evolution of the primine and secundine, or coats of the ovule, and presses upon the nucleus, the parenchyma of which is absorbed from the interior towards the exterior. This cellule is the sac of the embryo (membrana amnii Malp. sac embryonnaire Brong. quintine Mirb.) and exists in all the flowering plants, without exception *before fecundation*.

b. The contents of the sac of the embryo are a formative matter for the cellular tissue, which, sooner or later, often before fecundation, developes itself in the sac, and when not absorbed, during the growth of the embryo, forms the *endosperm*, (Albumen of most authors.)

c. The grain of pollen consists essentially of a simple cellule, the membrane of which is as thin and transparent as water, and moreover in a state of vital development. The contents are fecula mucilage, or gum, in a word, the formative matters for cellular tissue; all the rest is indifferent and accidental to the character of the grain of pollen.

d. The ovary is always in free communication with the exterior; and when a true style exists, it is along its canal this communication is seen.

242. A cellular tissue, more or less peculiar, covers the placenta, the internal walls of the ovary, and the canal of the style, and terminates in the papillæ of the stigmata. This cellular tissue is the *conducting tissue*.

e. At the period of fecundation, the conducting tissue

(comprising the papillæ of the stigma) secretes a mucilaginous fluid, which is more or less perceptible upon its surface, and in the inter-cellular spaces.

f. The pollen, dispersed by the dehiscence of the anther, falls upon the stigma, and the essential membrane of the pollen elongates itself as a tube, which following the conducting tissue, extends itself to the placenta and ovule.

g. Arrived at the ovule, the pollen-tube enters the aperture of its integuments, traverses the summit of the nucleus (Mamelon d'impregnation Brong.), following the inter-cellular *meati*, and attains the sac of the embryo.

h. The pollen-tube *pushes the membrane of the sac before it*, folding it inside and around itself, causing its own extremity to penetrate in appearance the sac of the embryo.

243. The extremity of the pollen-tube, having thus attained the sac of the embryo, swells into a spherical or ovoid form, and its contents change into cellular tissue. It produces the lateral organs, one or two cotyledons; but the original extremity, forming the plumula, remains more or less distinct.

i. The part of the pollen-tube, situated above the embryo, and which is strangled by this duplicature of the embryo sac, which surrounds it, is obliterated sooner or later, so that the embryo is effectively contained in the embryo sac.

k. In consequence of their development, the other parts of the ovule give birth to the integuments of the grain, and to the albumen; but we cannot determine, in a general manner, to which of the young organs of the ovule the several parts of the seed are related. This determination must result for each family, by a study of its special mode of development.

l. *From these facts it results, that we have named the sexes in plants quite wrong, for the grain of pollen must be looked upon as giving the germ of the new being; and, therefore, the anther is a female organ, and the sac of the*

embryo is to be regarded as the male principle, but which only dynamically determines the organization of the material foundation.

244. Professor Wydler of Berne, after an examination of the views of Schleiden, connected with observations made by himself upon the function of generation in the vegetable kingdom, comes to the following conclusions :—

1st. Plants have not their sexes disposed in the manner hitherto believed.

2nd. The anther, so far from being a male organ is a female one—it is an ovary; the grain of pollen is the germ of a new plant, the tube of the pollen becomes the embryo.

3rd. The transformation of the tube into an embryo, takes place within the embryo sac, and which seems to determine its organization, and prepares for it its first nourishment.

4th. The teguments of the ovule serve as a protecting abode to the embryo.

5th. The embryo lies freely in the embryo sac, it presents, in respect to the ovule, an inverse position, its base (radicular extremity) being directed towards the micropyle, its summit (cotyledonary extremity) to the chalaza.

245. In the "Annales des Sciences Naturelles," are the following remarks of M. Mirbel and Ad. Brongniart, on the views of Schleiden and Wydler :—

"For many years," says Mirbel, "I have laboured with M. Spach, to illustrate the origin of the several organic systems of the flower, and the succession of their developments. I have read, with great attention, the two important memoirs published by M. Schleiden. This phytologist is, in my opinion, an excellent observer, an original and ingenious writer ; nevertheless, many of his conclusions appear to me hazardous. He has seen the tube of the pollen penetrate through the endostome and exostome into the interior of the ovule. I do not deny the fact—others have also seen it. He has seen in the

nucleus a little membranous sac, (that is to say a utricle) which he considers as the first sketch (ébauche) of the embryo. This is not in opposition with what I have seen and published. But he affirms, that this sac is no other than the extremity of the tube—and this is what is to be doubted; according to this philosopher, the doctrine of the existence of sexes in plants is erroneous. The analogy which has been supposed to exist with animals is untenable. To the stamen alone belongs the generative power; the pistil only serves the purpose of gestation. M. Spach and I hope, however, to prove, that *in certain species*, the utricle which is supposed to commence the embryo already exists at an epoch when the pistil is enveloped in such a manner that the tube of the pollen can find no practicable way to arrive at it." Brongniart recals to mind, "that in his memoir upon the generation of plants, he has proved, that in some plants, and particularly in the Cucurbitaceæ, the embryo vesicle looked upon by Schleiden, as formed by the extremity of the pollen-tubes, existed before fecundation had taken place. Since when, he is farther assured of the extension of the tubes of pollen to the summit of the nucleus, and of their adherence with this part of the ovule in a great number of plants; but that it appears very doubtful to him, that the extremities of these tubes are the origins of embryos, as M. Schleiden and Wydler pretend."

246. In connection with this it is best perhaps to mention the recent discoveries of Mr. Griffiths, who has proved the remarkable fact of the *ovule* in Loranthus and Viscum not being formed till *some time after* the diffusion of pollen on the stigma. The results of his observations, which only can be given, are that—

a. During an early period the ovary is solid.

b. That the ovule is formed posterior to fecundation, and that it manifests itself in a cavity formed by an excavation of the tissue of the ovary.

c. That the first development of the embryo appears

a long time after that of the ovule, and that the embryo is attached to the summit of the latter by a cellular cord or funiculus.

247. In summing up, Mr. Griffiths observes, that this remarkable fact of the formation of the ovule after impregnation, tends materially to increase the difficulty of comprehending or even forming a conjecture upon the nature of the first degree of the formation of an embryo. It is evidently in complete disagreement with the idea that the ovule is a receptacle adapted or necessary for the development of the embryo, which, according to this opinion, is supposed to proceed entirely and directly from the anther.

248. Endlicher seems to have been the first (at least according to his own work dedicated to Dr. Brown,) who had his doubts of the truth of the hitherto received opinions of the generation of plants, and has promulgated that the anthers are to be likened to the ovaria of animals, and the ovulum to the uterus; but that the male organ is to be looked for in the stigma.

249. Before concluding this part of the subject, we may remark, that the power of generating hybrids exists in the vegetable as well as the animal kingdom; and in the former the instances of mules are of far more common occurrence than in the latter.

250. It is said that more pollen is required to fertilize a plant in the way of Hybrid generation, than in the regular manner, and that the plants produced are only fertile themselves to the third or fourth generation.

251. *Propagation.* Plants may be propagated in various ways by *slips* or *cuttings, layers, graftings,* and *bulbs,* etc. In propagating by *slips,* a portion is cut from the plant intended to be propagated, and either placed at once in the ground, or else upon a cut surface on another tree of the same family, the latter process being called *grafting.* In grafting, the slip cut from the tree to be propagated, is called a *scion,* and the tree upon which it is placed, the *stock;*

the union of the scion with the stock is effected by means of the *cambium* which exudes from the cut surfaces of the two portions, becoming organized, and producing complete union. "As the graft is merely an extension of the parent plant from which the scion came, and not, properly speaking, a new individual, so it is found to be the best method of propagating approved varieties of fruit trees, without any danger of altering the quality of the fruit. Till lately grafting was confined to the ligneous plants, but it is now successfully practised on the roots and shoots of herbaceous vegetables; and the Dahlia is grafted by the root, the Melon on the Gourd, the Love-apple on the Potatoe, etc., by the shoot."—(Loudon.)

252. Plants may be otherwise propagated, as by means of the *bulbs* generated in the scales of larger bulbs; by the *latent buds* in the tuber, as of a Potatoe; by the *buds* occurring sometimes on the leaves, and upon the stem in the axillœ of other buds, etc., etc.; but upon the whole of this subject the practical works of Loudon should be consulted.

DIVISION III.

PATHOLOGY.

1. Under this head we shall only enumerate the autumnal or hibernal colouration of the leaf, its fall, and the occurrence of ergot and of galls—though the propriety of ranking one of these phenomena under this title, may, perhaps, be questioned.

2. *Hibernal colouration*, etc., etc. Leaves may be divided into two great classes; those that change their colour and fall off in the autumn, or a little later, and those that change their colour in the autumn, but preserve their leaves through the winter.

3. In some plants a discolouration of the leaf takes place some time before it falls, but in others the fall occurs whilst the leaf is yet green, and sometimes the discoloured leaf remains for a considerable time upon the stem.

4. Mohl has stated that the change of colour has no connection with the death of the leaf in which it occurs; however it may be dependent upon its altered functions, and that the death going along with the discolouration is only accidental.

5. The discolouration of the leaf, however, appears to me more nearly related to the decay of vegetative vigour than is by some apparently allowed; and this

seems to be shown by the nature of Evergreens, which we know are hardy plants, in one sense of the word, and are able to keep up a degree of vegetative vigour, when others do not, or cannot, although they are often unable to bear the same degree of cold which these plants may, in consequence of their dormant, or as it were, hybernating condition. In Evergreens we often find a discolouration taking place during winter, and the leaves becoming green again on the return of activity in the spring.

6. According to Berzelius, the yellow colour in the autumnal tint of leaves has no connection with the yellow colour, or anthoxanthin, of the coloured parts at this or other periods, but is a peculiar matter between fatty oil and resin, which he calls *xanthophyll;* and says, in regard to its origin, "We have every reason for believing, since the green colour disappears and a yellow takes its place, that the xanthophyll has its origin in the green by means of a change in the organization of the leaf, produced by the cold, and thus giving rise to altered organic processes. The brown colour has likewise no connection with the yellow, and the different proportions in which this brown occurs with the yellow, give rise to the diversity of tints in autumnal colours."

FALL OF THE LEAF.

7. Various opinions have been given upon the subject, but the causes of this phenomenon have been considered as too much dependent upon individual circumstances.

8. It does not appear to me that it takes place from the derangement of any *particular* structure or function producing death of the part; and then its separation from the healthy ones, but that leaves possess, as Vrolick believed, a peculiar life, in which various periods may be distinctly marked; and that when they fall they have attained their greatest age, the whole func-

tions of the organs having been gradually decaying up to that period; when they have decayed completely—the part thence becoming dead or sphacelated, is thrown off from the healthy portions. The separation of these dead portions from the sound ones, is no more dependent upon the division of the spiral vessels or such individual circumstances, than separation of a gangrenous part from an animal body is upon a solution of a continuity in the arteries or veins, but is brought about by some general process affecting the *whole structures* at the line of demarcation between the two portions, a local action having its origin in the whole vital powers of the individual.

9. Du Petit Thouars gave as a reason for the fall of the leaf, a snapping of the spiral vessels, which keep up the communication from the leaf to the interior of the plant, brought about by the increase of distance taking place between the leaf and the medullary sheath by the deposition of new wood between them; and Decandolle, the hardening and choking up of the vascular and exhaling structures which ensue from the solid matters left after the exhalation of their dissolving media.

ERGOT.

10. The disease of *Ergot*, or *Spur*, is seen attacking certain kinds of Grasses, chiefly used for domestic purposes; and more especially *Rye*.

11. Some have looked upon it as a disease of the grain occurring spontaneously, others as the result of injury by insects; but it is now generally considered that Decandolle has sufficiently proved it to be a distinct parasitic plant, which locates itself in the ovary of the grass. By the presence of the Acinula clavus in the ovarium, the seed and its coverings, instead of being properly developed, are perverted at an early period of their growth, becoming partially mixed up with the

fungus which protrudes from the husk in the form of a club-shaped body.

12. This disease is more commonly met with on the continent than with us; and is chiefly seen attacking plants in a poor and wet soil.

13. The most remarkable point connected with the diseased state of the Grass is that when the diseased structure is received into the human system, a tendency to gangrene very often fatal, arises, which takes place in the extremities.

14. This happens in those cases in which bread, made of the diseased grain, has been eaten.

15. When some of the fungus is taken in small quantities by the female during parturition, strong muscular contractions of the uterus ensue; its action upon the uterus, however, is not alone confined to this period, as in Germany it has been lately employed, and seemingly with much advantage, in profuse and violent menorrhagia.

GALLS.

16. The plant most liable to the attacks of this disease is the Oak; it consists in the production of a number of excrescences upon the petioles, leaves, etc., of the plant, which are caused by an insect, the Cynips quercifoliæ, piercing with its sting the substance of the plant, and then depositing its eggs in the small opening it has left.

17. The irritation which this produces, occasions, as it always does in organized bodies, a greater flow or modified dynamic state of the fluids at the part, deposition of matter takes place at the wound, and an excrescence is the result.

18. Dr. Thomson says, "it is puzzling to conceive how the insertion of so minute a body as the egg of the

Cynips, should cause so singular a divergence from the ordinary growth of the part. The simple puncture and the mere mechanical irritation are not sufficient to explain the phenomenon in a satisfactory manner. I am, therefore, disposed to think, that some acrid secretion is injected from the ovipositor along with the egg, which acting locally, like the vaccine virus, or any other acrid lymph, that in the animal body produces a specific local change in the structure of the part, is the chief cause of the irritation."

DIVISION IV.

SYSTEMATOLOGY.

1. Very early indeed are the evidences to be seen of an attempt upon the part of man to trace out analogies which might exist between the various individual plants which came within his observation; these analogies, however, at the first onset were observed only in the most common and self-evident relationships which the individuals bore to each other, and no knowledge of anything beyond them existed at the time. Since these early trials to the present moment the signs looked upon as conveying the evidences of relationship have been gradually altered, because the nature of the facts, as entitling us to establish such connection, have been looked upon differently by those tracing it. Sometimes the most limited views have been taken of what those circumstances should be which entitle us to collect together many beings, and to say, these are sufficient to show their relation to each other, and their relative situation in the scale of bodies; and on the other hand the most extended notions have existed; the structure of these beings has been minutely examined; the agreements and disagreements they bear to each other in the nature of their several parts established, and a connection between these parts with the powers giving rise to the uses to which the individual is put, endeavoured to be traced.

2. We shall not, however, enter into any discussion concerning the various opinions which have been held upon the subject of the affinities of plants to each other, or upon the relative value of the different systems of arrangement formed upon these views. Such subject is essentially critical, and must be judged by an extended knowledge of particular and individual facts, ere we can hope to determine upon the value of the general and universal rules. The only remarks necessary to be made appear to us to be the following:—

3. The various Systems of Classification for arranging plants in connection with each other may be divided into two kinds, the Artificial and Natural.

4. *Artificial* systems are formed by taking note of one or two circumstances only, in which a number of plants happen to agree, and so forming a group of them, although they may differ, in every other respect, most distinctly from each other. *Natural* systems are formed, not upon the observance of any single or few resemblances that a number of plants may be found to bear to each other; but upon a general agreement of all their material points of structure, and which plants are not brought together unless they do so agree. *Artificial* systems, by employing a few simple characters only, afford groups of plants, the knowledge of whose ruling principles offers no evidence of the general character of the individuals ranking under them, either of structure or of use. *Natural* systems, by requiring the agreements of grouped plants to be many and general, afford in a knowledge of the principles of these groups, a true idea of the structure and uses of the members composing them, and therefore balance the greater trouble necessary to observe these many and general agreements, by affording an intuitive evidence, as it were, of a great number of other circumstances always included within, and found to be subsidiary to them; whilst *artificial* systems afford a ready arrangement in which the station of a plant can be easily found

from the less trouble to determine the guiding points of the inquiry. Finally, by the one we unfold an extended system of organization and its results; by the other we form a catalogue which is easily referred to, but it must be owned not one—raisonné.

5. The best artificial system is that of Linnæus; the most universally received natural one is that of Decandolle. Of these two alone we shall speak, giving a general view of the former, but entering more into detail as regards the latter.

The Artificial, or Sexual System of Linnæus.

6. In 1731 Linnæus gave to the world a system for arranging plants in definite groups, which groups were made to depend upon the number, position, and relative size or connection of the organs of generation. The most general divisions or *classes* of it, were twenty-four in number; twenty of these derived their characters from the stamens; three from the relations of the stamens and pistils; and one upon circumstances peculiar to it alone, a negation of generative organs, analogous to those indicating the other division. The next general divisions, or orders, depended chiefly upon the relations of the pistils, though sometimes upon those of the stamens.

CLASS.	SIGN OF	EXEMPLIFIED IN
1. Monandria	One stamen in each flower. as in	Zingiber officinale.
2. Diandria	Two stamens	Olea europæa.
3. Triandria	Three stamens	Saccharum officinarum.
4. Tetrandria	Four stamens	Rubia tinctorium.
5. Pentrandria	Five stamens	Hyoscyamus niger.
6. Hexandria	Six stamens	Scilla maritima.
7. Heptandria	Seven stamens	Trientalis europæa.
8. Octandria	Eight stamens	Polygonum bistorta.
9. Enneandria	Nine stamens	Laurus cinnamomum.
10. Decandria	Ten stamens	Cassia senna.
11. Dodecandria	Eleven to nineteen stamens	Canella alba.
12. Icosandria	Twenty or more stamens placed on the calyx	Rosa centifolia.

CLASS.	SIGN OF	EXEMPLIFIED IN
13. Polyandria....	Twenty or more stamens placed beneath the ovary..............	Papaver somniferum.
14. Didynamia....	Four stamens; but two of which are longer than the others......	Mentha piperita.
15. Tetradynamia.	Six stamens; but four of which are longer than the other two ...	Sinapis nigra.
16. Monadelphia.	Stamens united by their filaments into a tube.	Malva sylvestris.
17. Diadelphia....	Stamens united by their filaments into two bundles............	Glycyrrhiza glabra.
18. Polyadelphia..	Stamens united by their filaments into three or more bundles	Melaleuca minor.
19. Syngenesia....	Stamens united by their anthers, the flowers collected..............	Anthemis nobilis.
20. Gynandria....	Stamens and pistil connected together......	Orchis mascula.
21. Monœcia	Stamens and pistils in separate flowers, but both on the same plant.	Ricinus communis.
22. Diœcia	Stamens only in the flowers of one plant, and pistils only in the flowers of another of the same species....	Smilax sarza.
23. Polygamia. ...	Flowers containing stamens only, pistils only, and both stamens and pistils, on the same plant, or on others of the same species.	Acacia vera.
24. Cryptogamia..	Generative organs and floral coverings not evident as analogous to the preceding classes..	Chondrus crispus.

7. It will be seen that in the above system the first eleven classes are made to depend upon the *number* only of stamens; in the formation of the twelfth and thirteenth, position along with number is respected; in the fourteenth and fifteenth, number and relative size; in

the sixteenth, seventeenth, and eighteenth, relationships of connection of the filaments of the stamens; in the nineteenth, of the anthers; in the twentieth, of the stamens and pistils; in the twenty-first, twenty-second, and twenty-third, the sexual relations of the individuals in regard to uni-sexuality and hermaphroditism, are the governing principles; and in the twenty-fourth and last, the apparent want of analogy in the reproductive structures of certain plants, to those upon which the foregoing classes are founded.

8. The next most general divisions of the system are the *orders* which are formed upon the number of styles or stigmas, as far as relates to the first thirteen classes, and are named

Monogynia, plants which have....	1 style.
Digynia........................	2 styles.
Trigynia.	3 styles.
And so to Polygnia... -	more than 12 styles.

The whole of the orders do not occur in each class; sometimes only two or three, as Monogynia, Digynia, and Tetragynia; in the fourth class Tetrandria.

9. In the 14th class, Didynamia, there are two orders which are made to depend upon the nature of the ovarium; or as Linnæus considered them, as to whether the plants had naked or covered seeds. The first order is Gymnospermia, in which the ovarium is 4-lobed, or with naked seeds, according to the old erroneous notions; and the second is Angiospermia, in which the ovarium is not lobed, or with covered seeds.

10. In the 15th class, *Tetradynamia*, there are two orders formed upon the nature of the fruit. The first is *Siliculosa*, in which the plants have a short pod, or one broader than it is long; the other, *Siliquosa*, in which the pods are much longer than they are broad.

11. In the 16th, 17th, and 18th classes, *Monadelphia*, *Diadelphia*, and *Polyadelphia*, the orders are formed upon the number of the *stamens*, and receive the same

terms as designate the first thirteen classes, *Monandria*, *Diandria*, and so on to *Polyandria*.

12. The nineteenth class, *Syngenesia*, containing plants whose flowers are collected together within a common involucrum, has six orders according to Linnæus; but five only are generally allowed. These are *Polygamia æqualis*, in which the plants have the florets both of the disk and ray *hermaphrodite*; *Polygamia superflua* having those of the disk hermaphrodite, and those of the ray pistilliferous; *Polygamia frustranea* having those of the disk *hermaphrodite*, and those of the ray *neuter*; *Polygamia necessaria*, having the florets of the disk *staminiferous*, those of the ray *pistilliferous*; and *Polygamia segregata*, having the florets, which are included within the common involucrum, provided with proper calyces besides. Theother order, *Monogamia*, is founded upon the plants not having their flowers collected together in heads. These plants are now put under other classes.

13. The 20th, 21st, and 22nd classes, *Gynandria*, *Monoceia*, and *Diœcia*, have their orders dependent upon the number and relationship of connection of the stamens, and receive their names accordingly.

14. The 23rd class has three orders, *Monœcia*, *Diœcia*, and *Triœcia* formed as these classes are.

15. The 24th, or last class, *Cryptogamia*, has the orders dependent upon the general natural relationships the plants bear to each other, as Filices, Musci, etc.

16. The following table will give a general view of the System of Classification of Linnæus :—

				Character	CLASSES.	ORDERS.
SEXUAL ORGANS APPARENT.	FLOWERS HERMAPHRODITE.	*Stamens distinct from the pistil.*	Stamens distinct from each other.	1 stamen	1. *Monandria*	Monogynia, Digynia.
				2 stamens	2. *Diandria*	Monogynia, Digynia, Trigynia.
				3 ——	3. *Triandria*	Monogonia, Digynia, Trigynia.
				4 ——	4. *Tetrandria*	Monogynia, Digynia, Tetragynia.
				5 ——	5. *Pentandria*	Monogyn., Digyn., Trigyn., Tetragyn., Pentagynia., Polygynia.
				6 ——	6. *Hexandria*	Monogyn., Digyn., Trigyn., Tetragyn., Hexagynia, Polygynia.
				7 ——	7. *Heptandria*	Monogynia, Digynia, Tetragynia, Heptagynia.
				8 ——	8. *Octandria*	Monogynia, Digynia, Trigynia, Tetragynia.
				9 ——	9. *Enneandria*	Monogynia, Trigynia, Hexagynia.
				10 ——	10. *Decandria*	Monogynia, Digynia, Trigynia, Pentagynia, Decagynia
				11 to 19	11. *Dodecandria*	Monogyn., Digyn., Trigyn., Tetragyn., Pentagyn., Dodecagynia.
				20 or more stamens on the calyx	12. *Icosandria*	Monogynia, Pentagynia, Polygygina.
				—————— receptacle	13. *Polyandria*	Monogy., Digy., Trigy., Tetragy., Pentagy., Hexagy., Polygynia.
				2 long and 2 short	14. *Didynamia*	1. Gymnospermia, seeds naked, or Ovarium 4-lobed. 2. Angiospermia, seeds in a seed-vessel, or Ovarium not lobed.
				4 long and 2 short	15. *Tetradynamia*	1. Siliculosa, pericarp a silicula. 2. Siliquosa, pericarp a siliqua
			Stamens united to each other.	By the filaments: In 1 fasciculus	16. *Monadelphia*	Triandria, Pentandria, Heptandria, Octandria, Decandria, Endecandria, Dodecandria, Polyandria.
				By the filaments: In 2 fasciculi	17. *Diadelphia*	Pentandria, Hexandria, Octandria, Decandria.
				By the filaments: In several fasculi	18. *Polyadelphia*	Dodecandria, Icosandria, Polyandria.
				By the anthers	19. *Syngenesia*	1. Polgymia, Æqualis, all the florets hermaphrodite. 2. —— Superflua, florets of the disk hermaphrodite, of the ray female. 3. —— Frustranea, florets of the disk hermaphrodite, of the ray neuter. 4. —— Necessaria, flor. of the disk male, of the ray female. 5. —— Segregrata, each flor. with a sep. calyx.
		Stamens united with the pistil			20. *Gynandria*	Monandria, Dian., Trian., Tetran., Pentan., Hexan., Octan.
	FLOWERS UNISEXUAL.			Male and female flowers on the same plant	21. *Monœcia*	Monandria. Diand., Triand. Tetrand., Pentand., Hexand., Polyandria, Monadelphia, Polyadelphia.
				—————— 2 different plants	22. *Diœcia*	Monandria, Diand., Triand., Tetrand., Pentand., Hexand., Polyand., Monadelphia.
				Hermaphrodite, male, and female flowers on the same or on different plants	23. *Polygamia*	Monœcia, Diœcia, Triœcia.
SEXUAL ORGANS NOT APPARENT					24. *Cryptogamia*	Filices, Musci, Hepaticæ, Characeæ, Algæ, Lichenes, Fungi.

17. Thunberg, Liljebad, Richards, etc., have proposed alterations in the above system in order to do away as much as possible with some of the incongruities and wants which are experienced in it. They have been little attended to, however; the original arrangements alone being employed, when the system is called into requisition; and in no more valuable way has it been done than by Sir W. J. Hooker, in illustrating the Flora of our own country.

The Natural System of Decandolle.

18. In the year 1789, just eleven years after the death of Linnæus, a *natural system* for the arrangement of plants was proposed by A. L. de Jussieu.

19. A new epoch in science was thus established by this individual, to whom all praise is due for enabling the world to conceive in a philosophical manner the relationships which the members of the vegetable kingdom bear to each other: as time went on, however, it was found that circumstances arose over which the system of Jussieu did not effectually rule, and modifications and alterations of it were made to meet them. From then up to the present moment, the *system of natural arrangement* has been making rapid advances, the key-stone of the arch being giving by Jussieu; but unfortunately such numberless alterations, modifications, and new arrangements, have been proposed, and, by their *authors* promulgated in their systematic works, that the arrangement exhibits a new aspect in the hands of every one who aspires to obtaining the soothing consolation of "*my system;*" and not only this, but the *new* system is made to speak a sort of *provincial dialect* which no one but those living under its influence can (if he wishes) understand.

20. That certain modifications have been most serviceable, is no doubt true, and *will* arise along with, and

in proportion to, the increase of our knowledge, as evidences or results of it; but such necessities of science are totally different from the imaginations of its votaries.

21. It is particularly unfortunate for the student that when he dips into the systematic works of the day, instead of finding them to be a clue of thread to guide him out of the forest, they turn out to be the forest itself, and a very dark one as well; should he wish to know what is understood by the world concerning the subject of which the author is speaking, he finds lines of synonymes, to which his author is charitably adding another, leaving him quite in doubt and perplexity concerning a unanimity of opinion regarding the object of his search.

22. The system of Decandolle is the one to which the most general acceptation of the world has been given, and which we shall now enter into in some detail. The general view of its most important division is best seen by the following table, A, B, C, being the three grand divisions of the arrangement, to which all the others are subsidiary.

A EXOGENÆ. *Plants having a pith, and more or less distinct zones of woody matter, and harder at the centre than elsewhere.*	DYCHLAMYDEÆ. *Perianth double, or calyx and corolla distinct from each other.*	THALAMIFLORÆ. *Petals distinct, stamens hypogynous.*	Natural Families.
		CALYCIFLORÆ. *Petals distinct, stamens perigynous.*	Natural Families.
		COROLLIFLORÆ. *Petals united.*	Natural Families.
	MONOCHLAMYDEÆ. *Perianth single.*	FLOWERS PERFECT, EACH USUALLY HAVING STAMENS AND PISTILS.	Natural Families
		FLOWERS MONŒCIOUS OR DIŒCIOUS.	Natural Families
B ENDOGENÆ. *Plants having no true pith, their woody matter being in more or less distinct bundles, and softer at the centre than at the circumference.*	PETALOIDEÆ. *Floral coverings, foliaceous.*		Natural Families.
	GLUMACEÆ. *Floral coverings, glumaceous.*		Natural Families.
C CRYPTOGAMIA. *Plants having no true flowers, and their generative organs not stamens and pistils.*	ÆTHEOGAMIÆ. *Plants provided with stomata.*		Natural Families.
	AMPHIGAMIÆ. *Plants destitute of stomata.*		Natural Families.

23. We may now describe more particularly the essential characters of the various divisions given in the table, under the least general of which we shall arrange the different *natural families*, or collected groups, of the members of the vegetable kingdom, and give their characteristic signs, etc.

24. This last subject has been treated by us thus :— We have selected those natural families which yield a plant or plants held to be *officinal* by the London College of Physicians; the characters of a family necessary to be known by the student are first given, then the geographical relations of it, then its most generally marked properties, medicinal or economical, and, finally, the officinal plants yielded by it.

EXOGENÆ OR DICOTYLEDONEÆ.

Stem having a central cellular system or pith, the woody matter existing in the form of compact zones more or less concentric to the pith, the last-formed zone being farthest from it. *Leaves* with a reticulated system of venation and articulated with the stem. *Floral* structures developed upon a quarternary or quinary type. *Embryo* with two cotyledons and an exorrhizal mode of germination.

Though the above are the essential characters of the plants collected under this grand division, we are not to suppose that a case cannot exist in which one or other of them may be found wanting, and yet the plant be entitled to rank here just as well; it is not so entitled merely because it agrees in one or even two particulars with the characters of the group, but because *the general combination of its characters* is such, that on the whole its affinity is distinctly traced, though it may

happen that it is devoid of some particular mark found to exist in those individuals with which, notwithstanding, we may discover some affinity. We shall presently notice a few examples in which some characters exist different from those generally met with in the plants with which these are properly allied, and merely remark now, that suppose the stem of a plant is so little developed as not to have arrived at a state in which the exogenous structure may be visible, we have then the dicotyledonous embryo to refer to; or if we cannot be satisfied as to the nature of the stem, we have the quarternary or quinary type in the organs of fructification; should the leaves present a parallel venation, we have still the embryo and floral envelopes to guide us; or should the nature of the embryo be doubtful, we may have the reticulated venation, and exogenous stem, and so on.

B

ENDOGENÆ OR MONOCOTYLEDONEÆ.

Stems destitute of a central cellular system or true pith, the woody matter existing in the form of more or less distinct and separate bundles, and not forming concentric compact zones. *Leaves* with a parallel system of venation, and often sheathing the stem. *Floral* structures developed upon a ternary type. *Embryo* with one cotyledonary body, and an endorrhizal mode of germination.

The same remarks hold as good in this place as they did before, that the deficiency of one of the above characters, or the presence of another foreign to the principles of the group, does not exclude a plant from its station here, supposing that the *general combination of its characters* are such as to allow us to establish a general affinity.

When the organization of the stem may be doubtful, we have the ternary type in the floral structures; if the quarternary type should be seen, we have the parallel venation and monocotyledonous embryo, etc.

CRYPTOGAMIA.

Stems analogous to those of plants in general, not always existing, when existing may have true woody matter in the form of variously (often sinuous) shaped bundles running down within it, or may consist of cellular tissue alone. *Leaves* or foliaceous expansions, when existing, having their veins dichotomous, or destitute of them entirely. *Flowers* (as generally understood by the term) not present. *Sexual* organs not distinct, or not stamens and pistils, producing no embryo but multiplying by sporules.

The following examples will show the student the deviations that may exist in plants from a general character found existing in their allies. Among the *Exogenæ*, some of the Coniferæ have from two to ten cotyledons, Schizopetalon Walkeri, a cruciferous plant, has four, and Cuscuta has none at all; the Ranunculaceæ may have the sepals and petals developed upon a ternary type; Nepenthes has no concentric zones or medullary rays; the Peppers have woody matter in the form of bundles, and Phytollacca dioica is destitute of liber. Among the *Endogenæ*, two cotyledonary bodies may be seen in Triticum; the scales of the single floral covering in Potamogeton are developed upon a quarternary type; a reticulated system of venation may be seen in the leaves of Arum maculatum, and a corky bark upon the rhizoma of Tamus elephantipes. Nevertheless, as "the differential signs of natural associations

are necessarily collective, and relative differences often depend on relatively different combinations only; one or other, or even all the elements, may in turn be absent, and yet the concurrence of several, or of the majority, be rightly deemed conclusive."—(Burnett.)

The signs of the other divisions of the system are sufficiently marked upon the table. The following is the arrangement of the different natural families containing the officinal plants of the Ph. Lond. under this system, and which are described in their turn.

EXOGENÆ.

Thalamifloræ.

1. Ranunculacaæ.
2. Menispermaceæ.
3. Papaveraceæ.
4. Cruciferæ.
5. Polygaleæ.
6. Lineæ.
7. Malvaceæ.
8. Aurantiaceæ.
9. Guttiferæ.
10. Meliaceæ.
11. Ampelideæ.
12. Oxalideæ.
13. Rutaceæ.
14. Zygophylleæ.
15. Diosmeæ.
16. Simarubeæ.

Calycifloræ.

17. Rhamneæ.
18. Anacardiaceæ.
19. Burseraceæ.
20. Leguminosæ.
21. Rosaceæ.
22. Myrtaceæ.
23. Umbelliferæ.

Corolliflorœ.

24. CUCURBITACEÆ.
25. CAPRIFOLIACEÆ.
26. CINCHONACEÆ.
27. VALERIANEÆ.
28. COMPOSITÆ.
29. LOBELIACEÆ.
30. ERICACEÆ.
31. STYRACEÆ.
32. OLEACEÆ.
33. APOCYNEÆ.
34. GENTIANEÆ.
35. CONVOLVULACEÆ.
36. SOLANEÆ.
37. SCROPHULARINEÆ.
38. LABIATÆ.

Monochlamydeœ.

39. POLYGONEÆ.
40. LAURINEÆ.
41. MYRISTICEÆ.
42. ARISTOLOCHIÆ.
43. EUPHORBIACEÆ.
44. URTICEÆ.
45. ARTOCARPEÆ.
46. ULMACEÆ.
47. PIPERACEÆ.
48. SALICINEÆ.
49. CUPULIFERÆ.
50. CONIFERÆ.

ENDOGENÆ.

Petaloideæ.

51. Aroideæ.
52. Smilaceæ.
53. Asphodeleæ.
54. Colchicaceæ.
25. Palmæ.
56. Drymyrhizeæ.
57. Marantaceæ.

Glumaceæ.

58. Gramineæ.

CRYPTOGAMIA.

Ætheogamia.

59. Filices.

Amphigamia.

60. Lichenes.
61. Fungi.

EXOGENÆ.

Thalamifloræ.

1. RANUNCULACEÆ.

Sepals 3-6 mostly imbricate in œstivation and rarely persistent. *Petals* 3-15 distinct, in one or more rows, sometimes unequal but rarely absent by abortion. *Stamens* indefinite, hypogynous, with adnate and mostly reversed anthers having a longitudinal dehiscence. *Pistilla* numerous on a torus. *Ovaria* sometimes united and many-celled; but at others distinct and one-ovuled. *Fruit*, dry akenia, or baccate, or follicular, with one or two valves. *Seeds* exarillate with a solid corneous albumen, a minute embryo and *cotyledons foliaceous* during germination.

Herbaceous, very seldom shrubby; the leaves generally divided, having a dilated half sheathing petiole, exstipulate; inflorescence variable.

Allied to Magnoliaceæ, a tribe not noticed by us, as it contains no officinal plant of the Ph. L., but includes in a section of it the Wintera aromatica of the Ph. E.

Geographical relations.—Temperate zones chiefly, Europe containing one-fifth of the whole; but occur in Japan, etc., where they become alpine.

Properties.—In general poisonous, ranking under the irritant and narcotico-acrid divisions of Beck; the poi-

sonous principle is volatile, and in some members of the family but little developed.

Officinal Plants.

Helleborus niger (officinalis.)
Delphinium staphisagria.
Aconitum paniculatum.

2. MENISPERMACEÆ.

Sepals and *petals* not to be distinguished from each other, the pieces arranged in one or more rows, hypogynous, and deciduous. *Stamens* monadelphous rarely free, *anthers* usually adnate and extrorse. " *Germen* of several carpels (or by abortion of a single ovary) subcoalescent by the basis of the styles which are terminal, and the *stigmata* simple, sometimes the carpels are connate, the *germen* multilocular, or by abortion celled." (Burnett). *Fruit* drupaceous one-seeded, and oblique or lunulate in form, the *embryo* of the seed turned in direction of the circumference, exalbuminous or nearly so, and the cotyledons sometimes distant from each other. *Twining* plants with cordate or peltate exstipulate alternate leaves, and monœcious or diœcious flowers.

Geographical Relations.—Intertropical Asia and America.

Properties.—Bitterness only present in some, but poisonous properties in others. Menispermum cocculus is a narcotico-acrid poison of Beck.

Officinal Plant.

Menispermum palmatum (Cocculus palmatus.)

3. PAPAVERACEÆ.

Sepals 2, deciduous. *Petals* 4, or a multiple of that number, cruciate. *Stamens* some multiple of 4; (mostly indefinite, and more or less collected,) hypogynous, or apparently perigynous from the excavation of the peduncle; *anthers* two-celled, innate; *ovarium* one-celled, with parietal placentæ, and many-ovuled. *Fruit* mostly capsular, with many placentæ, or sometimes pod-shaped, with two placentæ. *Seeds* numerous, with albumen which is oily or fleshy, and a minute embryo at the base of the albumen. Cotyledons plano-convex, and foliaceous in germination.

Herbaceous (rarely shrubby plants,) with lactescent juice varying in colour, and alternate more or less divided leaves. The flowers are solitary and never blue; in Bocconia petals are wanting.

Allied to Cruciferæ, etc.

Geographical Relations.—Europe and North America chiefly, though they are found elsewhere, as in China and Japan for instance.

Properties.—Narcotic. This deleterious property resides in their juices, their seeds being oily, but not possessed of any soporific powers.

Officinal Plants.

Papaver rhœas
Papaver somniferum.

4. CRUCIFERÆ.

Sepals 4, cruciate, almost always imbricate in æstivation, and deciduous. *Petals* 4, cruciate, alternate to the

sepals. *Stamens* tetradynamous. *Torus*, or disk "small, sometimes supporting the germen, at others being furnished with nectariferous glands situated between the petals, stamens, and germen." *Ovarium* one, or spuriously two-celled, placentæ parietal. *Fruit*, a siliqua or a silicula, one, or spuriously two-celled, dehiscing by valves or indehiscent. *Seeds*, many, exalbuminous, with the embryo folded upon the cotyledons which are foliaceous in germination.

Herbaceous, rarely with a tendency to shrubbyness, with alternate and exstipulate leaves, and generally yellow or white flowers. Allied to Papaveraceæ, etc.

Geographical Relations.—Europe more especially, are unknown in equinoctial Africa, but extend on the other hand to Baffin's Bay and Melville Islands.

Properties.—Stimulant, often pungently so, and even acrid; but none are really poisonous. Their powers are owing to a volatile oleaginous principle, which, when moderated by a good proportion of amylaceous or mucilaginous material in the plant becomes a useful condiment.

Officinal Plants.

Cardamine pratensis.
Sinapis nigra.
Sinapis alba.

5. POLYGALEÆ.

Sepals 5, distinct, glumaceous or petaloid, and irregular, of which three are external, one being superior, and the other two anterior; and two internal and lateral. *Petals* 3 (sometimes 5,) hypogynous, one is larger than the others and anterior, and sometimes crested; the other two are superior, one being on each side of the

external superior sepal. *Stamens* mostly 8, hypogynous, usually monadelphous below, with clavate and one-celled anthers, which dehisce by terminal pores. *Ovarium* superior, of two cells, one placed anterior, and one posterior, the upper one occasionally abortive, ovules mostly solitary and pendulous from the apex of the placentæ. *Style* curved, occasionally oblique or hooded at its extremity, which may be entire or lobed. *Fruit* with a loculicidal dehiscence, rarely indehiscent, and drupaceous or winged. *Seeds* pendulous and solitary, carunculate, generally with much fleshy albumen, and the embryo with the radicle next the hilum.

Herbaceous or shrubby plants with exstipulate, mostly simple and alternate leaves, juices often lactescent, and the inflorescence generally racemose, the pedicles having three bractea.

Allied distantly to the Leguminosæ.

Geographical Relations.—Though a small family, pretty generally scattered over the globe, the genera being limited, however, to particular regions on it.

Properties.—Bitterness and astringency are the chief characters; but one member of the family, Polygala vemenata, is said to be poisonous. Senegine and Polygaline are principles said to have been obtained from some of the tribe.

Officinal Plants.

Polygala senega.
Krameria triandra.

6. LINEÆ.

Sepals 5 (rarely 3-4), continuous with the peduncle, imbricated during æstivation and persistent. *Petals* equal in number to the sepals, unguiculate and contorted

in æstivation. *Stamens* equal in number to the petals, and alternating with them, slightly monadelphous, with the vestigium of a filament between each; anthers two-celled, ovate, and innate. *Ovarium* with as many cells as there are sepals, styles distinct, equal to the cells, and capitate. *Fruit* capsular, acuminated from the persistent bases of the styles, many-celled, each cell being imperfectly divided into two, by a spurious partial dissepiment; each compartment containing one seed, which is inverted, compressed, and shining, having the inner layer of the testa tumid, and the albumen mostly wanting; the embryo is straight, with its radicle towardst the hilum.

Herbaceous, sometimes suffruticose plants, with entire exstipulate and mostly alternate leaves. Petals fugacious.

Geographical Relations.—Spread chiefly over the temperate and southern parts of Europe, and northern parts of Africa.

Properties.—Demulcent, and have great tenacity in their fibrous tissue. Oil is found in the seeds of some, which is sometimes purgative.

Officinal Plant.

Linum usitatissimum.

7. MALVACEÆ.

Sepals 5, more or less connate, often with bracteæ at their base, valvate in æstivation. *Petals* equal in number to the sepals, hypogynous, sometimes adhering to the tube of the stamens, contorted during æstivation. *Stamens* monadelphous, indefinite, hypogynous; anthers reniform, one-celled, and dehiscing transversely, pollen globose, and hispid; *ovarium* of several carpella placed

round a common axis, more or less connate or distinct. *Fruit* capsular or baccate, each carpel one or more seeded, the carpels sometimes united into one. *Seeds* sometimes hairy, almost or quite destitute of albumen; the embryo curved to the hilum, and the cotyledons plaited and foliaceous.

Herbs, shrubs, or trees, with more or less divided, stipulate, alternate leaves. Hairs stellate, peduncles mostly axillary.

Geographical Relations.—Most abundant in the torrid zone, and diminishing quickly towards the poles, though found as far as Moscow. In the tropics forming $\frac{1}{50}$ of the vegetation, and in Sweden $\frac{1}{233}$.

Properties.—Innocuous, abounding in mucilaginous juices.

Officinal Plants.

Malva sylvestris.
Althæa officinalis.

8. AURANTIACEÆ.

Calyx urceolate or campanulate, 3-4-5-toothed, adhering to the disk, marescent. *Petals* 3 to 5, broadest at their base, distinct or subconnate, exserted from the torus. *Stamens* equal in number to the petals or some multiple of their number, inserted on the disk; filaments flattened at their base, sometimes connate in one or more fasciculi; anthers terminal and innate; *ovarium* superior, many-celled, the style taper, stigma thick and slightly lobed. *Fruit* indehiscent, dry or juicy, with a leathery rind beset with receptacles of volatile oil, the cells sometimes filled with pulpy matter. *Seeds* numerous or solitary, attached to the axis, pendulous, often enclosing a plurality of embryos, chalaza evident;

embryo with large and thick cotyledons, and a conspicuous plumula.

Trees or shrubs with smooth stems and branches; leaves alternate, sometimes compound, the lamina articulated with the petiole, which may be winged. Over the whole plant predominate transparent receptacles of volatile oil, which give the leaves a dotted appearance.

Geographical Relations.—East Indies, China and Japan, are their principal habitats, but many species have become almost naturalized to the southern parts of Europe.

Properties.—Without exception innocuous, and much esteemed for their fragrant volatile oil, and delicious refreshing fruits. A transparent glutinous matter is found in some.

Officinal Plants.

Citrus aurantium.
Citrus medica.

9.° GUTTIFERÆ.

Sepals 2 to 6, persistent, round, membranous, often irregular and coloured, imbricated during æstivation. *Petals* 4 to 10, hypogynous, passing insensibly to sepals. *Stamens* numerous, sometimes combined in one or more fasciculi, hypogynous; anthers adnate, bursting inwards, sometimes bursting outwards or by a pore. *Disk* fleshy, occasionally five-lobed. *Ovarium* superior, 1-8-celled, one or many ovuled; style wanting, or very short; stigma peltate or radiate. *Fruit*, dry or succulent, one or many-celled and seeded, dehiscent or indehiscent. *Seeds* often arillate and placed in pulp,

exalbuminous; cotyledons thick and often inseparable from each other.

Trees or shrubs, (sometimes parasites,) with resinous juices; leaves entire, exstipulate, and opposite, coriaceous in texture, and with parallel lateral veins extending to the margin.

Geographical Relations.—Plants of tropical countries, especially met with in the equatorial regions of South America.

Properties.—The members of the family abound in acrid juices, which are viscid and of a yellow colour, and are obtained from wounding their bark; the fruits of many are eatable and said to provoke appetite.

Officinal Plant.

Stalagmitis cambogioides.

10. MELIACEÆ.

Sepals 4 to 5, more or less coherent. *Petals* equal in number to the sepals, hypogynous, with broad ungues, connivent or coalescent at their bases, and generally valvate in æstivation. *Stamens* mostly double the number of petals, sometimes equal or three or four times as many, monadelphous; anthers sessile upon the faux of the tube. *Disk* often much developed. *Ovarium* single, of several cells, ovules definite in number, stigmas distinct or combined. *Fruit* capsular baccate or drupaceous, many-celled, or by abortion one-celled, seeds sometimes winged and albuminous, but mostly the reverse. *Embryo* variable in form.

Trees or shrubs with alternate leaves, which are either simple or compound.

Geographical Relations.—East and West Indies, Ame-

rica and Africa; principally in the hotter parts of these countries, but one is found as far north as Syria.

Properties.—Aromatic and stimulating; the wood, especially of the members of subtype Cedreleæ, is very valuable.

Officinal Plant.

Canella alba.

11. AMPELIDEÆ.

Calyx small, nearly entire, or with 4-5 teeth, and open during æstivation. *Petals* 4-5, placed upon the edge of a disk surrounding the ovarium, subvalvate in æstivation. *Stamens* equal in number to the petals, and placed upon the disk; anthers ovate, versatile. *Ovarium* superior, two-celled, four-ovuled; style short. *Fruit* a nuculanium, generally one-celled by abortion, 4-5 seeded, or less. *Seeds* erect and bony, albumen hard, and the radicle taper and inferior.

Shrubs sarmentose or scandent, with swelled nodi, stipulate leaves, the upper ones being alternate, and the lower opposite; tendrils often present.

Geographical Relations.—Warmer parts of the temperate regions.

Properties.—Acid, saccharine, and astringent.

Officinal Plant.

Vitis vinifera.

12. OXALIDEÆ.

Sepals 5, free or slightly coherent at the base, equal, persistent, imbricate in æstivation. *Petals* 5, hypogy-

nous, equal, with erect ungues, contorted in æstivation. *Stamens* definite (10), often monadelphous at the bases; those opposite the petals form an inner series, and are longer than the others; *anthers* two-celled, innate. *Ovarium* five-angled and celled; *styles* five, filiform, stigmata various. *Fruit* capsular and membranous, five-cornered and celled, and from five to ten-valved. *Seeds* few, attached to the axis, striated; when young, enclosed within a fleshy integument, but which bursts at maturity; albumen subcartilaginous, embryo the length of the albumen, with a long radicle and foliaceous cotyledons.

Herbs, shrubs, or trees, mostly with alternate compound leaves; inflorescence various, but seldom solitary.

Geographical Relations.—Especially abundant at the Cape of Good Hope, Mexico, and Brazil, but found in all the hotter and temperate parts of the globe.

Properties.—Acid and slightly astringent; many members show evidences of irritability.

Officinal Plant.

Oxalis acetosella.

13. RUTACEÆ.

Calyx of 4 or 5 divisions. *Petals* equal to the divisions of the calyx with a twisted convolute æstivation. *Stamens* twice as many as the petals, (rarely three times). *Disk* sometimes dilated. *Ovarium* three or five-lobed and celled, the cells two-ovuled, rarely one or many, styles free or connate, stigmata simple or dilated. *Fruit* multi-capsular, the capsules being connate or more or less distinct; dehiscence loculicidal. *Seeds* equal to, or fewer than the ovules, with crusta-

ceous testæ; albumen fleshy, radicle superior, and cotyledons flat.

Herbs or shrubs with exstipulate alternate leaves, which are simple or compound, and covered mostly with pellucid dots.

Allied to Zygophylleæ, and two following families, very closely indeed.

Geographical Relations.—Natives of the southern parts of Europe, and of Levantine Africa, and Asia, but rarely met with in the tropics.

Properties.—Bitter and stimulating, and have strong unpleasant odours.

Officinal Plant.

Ruta graveolens.

14. ZYGOPHYLLEÆ.

Differing from *Rutaceæ* in having mostly opposite leaves furnished with stipules, and no pellucid dots; the albumen being fleshy, and cotyledons foliaceous, &c.

Geographical Relations.—Curiously scattered over various parts of the old and new worlds.

Properties.—Slightly acrid and bitter, but stimulating and diaphoretic.

Officinal Plant.

Guiacum officinale.

15. DIOSMEÆ.

Differing from *Rutaceæ* in the nature of their fruit, "the endocarp of which separates entirely from the

sarcocarp, both being two-valved, the valves dividing at the base, but connected by a membrane which bears the seeds," "seeds twin or solitary, albumen none."

Geographical Relations.—Abundant at the Cape of Good Hope and equinoctial regions of America; one genus is found in Europe.

Properties.—Bitter and stimulating, with fœtid odours, though sometimes with fragrant ones.

Officinal Plants.

Diosma crenata (now a Barosma.)
Galipea (aut Cusparia) febrifuga.

16. SIMARUBEÆ.

Differing from *Rutaceæ* in having "ovaria with but one ovulum, indehiscent drupes, and exalbuminous seeds, the membranous integument of the embryo and radicle being retracted within thick cotyledons."—(Jussieu.)

Geographical Relations.—Altogether tropical in their distribution.

Properties.—Intensely bitter. A principle called *Quassine* has been found in some members.

Officinal Plants.

Quassia amara.
Simaruba (olim Quassia) excelsa.

Calyciforæ.

17. RHAMNEÆ.

Calyx monosepalous, 4-5-cleft, and valvate in æstivation. *Petals* exserted from the faux of the calyx, cucullate, convolute in æstivation, and sometimes scale-like or absent from abortion. *Stamens* definite and opposite the petals. *Disk* fleshy, lining the tube of the calyx. *Ovarium* more or less immersed in the disk, 2-3-4-celled, the ovules solitary and erect. *Fruit* mostly fleshy and indehiscent, occasionally dry and indehiscent, variously celled. *Seeds* solitary and erect, albumen generally present and fleshy, embryo large, with large and flat cotyledons, but a short inferior radicle.

Trees or shrubs often having spines, with simple minutely stipulate, mostly alternate leaves. Flowers very often axillary.

Geographical Relations.—Representatives of the tribe may be found all over the world, save within the polar circle, but many of the genera are met with in particular countries only.

Properties.—The juice of the berries of many species is a very drastic cathartic, griping violently; but other members afford fruits and leaves which are eaten and used economically.

Officinal Plant.

Rhamnus catharticus.

18. ANACARDIACEÆ.

Calyx generally small and persistent, with from 3 to 7 divisions, imbricate in æstivation. *Petals* when pre-

sent, equal in number to the divisions of the calyx, and imbricate in æstivation. *Stamens* equal in number to and alternate with the petals, sometimes alternately shorter than the others, sometimes altogether wanting. *Disk* generally present and expanded. *Ovarium* almost always superior and single, occasionally 5 or 6; *styles* 1-4, sometimes wanting; ovule solitary, attached by its funiculus to the bottom of the cell. *Fruit* indehiscent and drupaceous. Seed exalbuminous. Embryo curved, with its radicle towards the hilum, cotyledons foliaceous or fleshy.

Trees or shrubs with exstipulate dotted alternate leaves; inflorescence either terminal or axillary, with bracteæ.

Geographical Relations.—Chiefly to be found within the tropics, but a few members extend to within the temperate latitudes.

Properties.—They abound with resinous or gummy juices, which are occasionally caustic and very poisonous.

Officinal Plants.

Pistacia terebinthus.
Pistacia lentiscus.
Rhus toxicodendron.

19. BURSERACEÆ.

"Differ from Anacardiaceæ (to which they are closely allied) in their compound ovarium and pinnated leaves, and also in the very general valvate æstivation of the calyx."—(Lindley.)

Geographical Relation.—Tropics.

Properties.—They have fragrant balsamic juices, often turpentiny or resinous.

Officinal Plants.

Boswellia serrata.
Balsamodendron myrrha.

20. LEGUMINOSÆ.

Calyx 5-parted, its divisions often unequal and variously combined. *Petals* usually five in number, irregular, exserted from the base of the calyx, which rests upon a small disk; the petals generally form a papillionaceous flower, but are sometimes equal and spreading. *Stamens* definite, perigynous, free, mono, di, or tri-adelphous; anthers versatile. *Ovarium* superior, simple, one-celled, generally many-ovuled. Style and stigma simple. *Fruit* leguminous or drupaceous. *Seeds* several or solitary, attached to the upper suture, and occasionally provided with a small arillus, embryo exalbuminous with its radicle either straight (Rectembriæ), or with it curved back upon the cotyledons (Curvembriæ). Cotyledons either remaining below or rising above ground at germination.

Herbs, shrubs, or trees, with alternate mostly compound leaves and having stipules; petioles swelled at their base. Inflorescence terminal, or axillary, the pedicels having bracteolæ at their base.

Allied to the next tribe Rosaceæ.

Geographical Relations.—Distributed generally over all parts of the world, but their maximum is in the tropics. In the islands of St. Helena and of Tristan d'Acûhna none are to be found.

Properties.—Only rivalled by the natural family of the

grasses, for their utility to man, and which is exemplified in such various ways, that they cannot admit of detail.

Officinal Plants.

Rectembriæ.	Acacia vera. Acacia catechu. Cassia fistula. Cassia lanceolata. Hematoxylon campeachianum. Tamar-indus indica.
Curvembriæ.	Astragalus verus. Cytisus scoparius. Copaifera officinalis. Glycyrrhiza glabra. Pterocarpus erinaceus. Pterocarpus santalinus. Myroxylon peruiferum.

21. ROSACEÆ.

Calyx 4-5-lobed, free or adherent with the ovarium. Petals 5, perigynous, equal. *Stamens* arising from the calyx, indefinite or definite, curved inwards in æstivation; anthers two-celled, bursting longitudinally. *Ovaries* superior or combined with the calyx and each other, one-celled, sometimes solitary; styles simple, often lateral, distinct or combined. *Fruit* a pome, or æterio, or cynarrhodon, etc. *Seeds* ascending or suspended, nearly without albumen; embryo straight, with fleshy or foliaceous cotyledons.

This family is divided into sub-tribes, the *Officinal Tribes* are

Amygdaleæ.
Dryadeæ.
Roseæ.
Pomeæ.

Amygdaleæ.

Rosaceæ with the tube of the calyx lined with a waxy disk. *Carpel* superior, solitary. *Fruit*, a drupe.—(Lind.)

Geographical Relations.—Exclusively found in the northern hemisphere; none having been discovered in South America, nor in any country south of the Line; only five or six approach the equator.

Properties.—The existence of Hydrocyanic acid in their leaves and seeds is most worthy to be noticed. They are otherwise astringent.

Officinal Plants.

Amygdalus communis, var. β, γ.
Prunus domestica.

Dryadeæ.

Rosaceæ with the calyx 4-5-cleft, but often bearing bracteolæ on its tube equal in number to the segments, and alternate with them; petals 5; the seed solitary, erect, or inverted.

Herbaceous, very seldom shrubby, with the leaves usually compound, stipulæ adhering to the petiole.—(Lind.)

Geographical Relations.—Though found in the tropical regions of America, and in the southern hemisphere, this sub-tribe is more immediately one of the colder climates of the northern hemisphere.

Properties.—Innocuous, and for the most part astringent.

Officinal Plant.

Tormentilla officinalis.

Roseæ.

Rosaceæ with the tube of the calyx urceolate, and the divisions spirally imbricate in æstivation, the *Fruit* is a cynarrhodon.

Shrubs with prickly or naked stems and pinnate leaves.

Geographical Relations.—Northern hemisphere alone.

Properties.—Fragrance and astringency.

Officinal Plants.

Rosa canina.
Rosa centifolia.
Rosa gallica.

Pomeæ.

Rosaceæ with a superior calyx; indefinite stamens inserted in a ring in the throat of the corolla. *Ovaries* from 1-5, adhering more or less to the sides of the calyx and each other; styles from 1-5; stigmas simple. *Fruit* a pome 1-5-celled. The endocarp is either cartilaginous, spongy, or bony.

Trees or shrubs with simple or compound stipulate alternate leaves. Flowers in terminal cymes, white or pink.—(Lind.)

Geographical Relations.—Temperate zone, and found exclusively in the northern hemisphere.

Properties.—The fruits of different species are eaten, but some, especially when uncultivated, are harsh and acid.

Officinal Plant.

Cydonia vulgaris. (Pyrus cydonia)

22. MYRTACEÆ.

Calyx 4-5, rarely 6-cleft, its tube adhering to the germen; imbricate in æstivation, the lobes sometimes united, continuing closed, and falling off on the expansion of the flowers. *Petals* equal in number to the divisions of the calyx, quincunical in æstivation, rarely more. *Stamens* two or three times the number of the petals, or indefinite; filaments either distinct or connate, curved inwards before flowering; anthers ovate, two-celled, with a longitudinal dehiscence. *Ovarium* inferior, 1-6-celled; style and stigma simple. *Fruit* various, drupaceous, baccate, etc., many-celled and seeded. *Embryo* exalbuminous, its radicle towards the hilum, but sometimes conferruminate with the cotyledons, forming one solid mass.

Shrubs or trees with simple exstipulate, mostly opposite leaves, having a vein running parallel to their margin and dotted. Flowers never blue.

Geographical Relations.—Tropical plants, with a decided tendency towards the equinoctial line, but represented in Europe.

Properties.—Stimulant and fragrant, from the volatile oil they contain; astringency is found in some.

Officinal Plants.

Caryophyllus aromaticus. (Eugenia caryophyllata)
Eugenia pimenta. (Myrtus pimenta)
Melaleuca leucadendron.
Punica granatum.

23. UMBELLIFERÆ.

Calyx entire or 5-toothed, sometimes obsolete. *Disk* fleshy and epigynous. *Petals* 5, exserted from the outer edge of the disk, often very much inflexed at the point, generally imbricate in æstivation. *Stamens* 5, alternate with the petals, incurved in æstivation ; *anthers* two-celled, dehiscing longitudinally. *Ovarium* inferior, crowned by the disk, two-celled, or rarely by abortion one-celled ; ovules solitary. *Fruit* of two carpels, with a central columella, adhering to it by their faces when young, but separating at maturity. Each carpel is traversed by longitudinal ridges, five of which are *primary* ridges, and the four alternating ones *secondary* ; and in the channels between the ridges are often *vittæ*, or receptacles for oil. *Seeds* solitary and pendulous, usually inseparable from the pericarp. *Embryo* minute, albumen plentiful and horny, the radicle towards the hilum.

Herbaceous, with fistula and furrowed stems, mostly compound alternate leaves, sheathing at their base. Inflorescence umbellate, often having general or partial involucra.

Geographical Relations.—Though found within the tropics, they belong more particularly to the colder parts of the temperate zone.

Properties.—The leaves and stems of the members of this tribe are often highly poisonous, and as a general rule to be always avoided when uncultivated, narcotic and acrid powers residing in them ; the Fruit is innocuous ; often stimulating from the essential oil it contains.

Officinal Plants.

Anethum graveolens.
Carum carui.

Conium maculatum.
Coriandrum sativum.
Cuminum cyminum.
Daucus carota.
Dorema ammoniacum.
Fœniculum vulgare.
Ferula asafœtida.
Galbanum officinale.
Pastinaca opoponax.
Pimpinella anisum.

Corollifloræ.

24. CUCURBITACEÆ.

Flowers monœcious or diœcious, but very rarely united. *Calyx* 5-cleft, deciduous, imbricate in æstivation, sometimes wanting. *Corolla* 5-parted, often intimately blended with the calyx, and scarcely distinguishable from it; very cellular in structure, strongly marked with reticulated veins, and sometimes fringed at the edges. *Stamens* 5, free or triadelphous, the filaments being connate in pairs, the fifth one remaining free, or sometimes diadelphous by its union; anthers two-celled, long and sinuous. *Ovarium* inferior, one-celled; placentæ parietal, many-ovuled. Stigmas thick, velvety or fringy. *Fruit* (a pepo) fleshy, crowned by the remains of the calyx. *Seeds* flat and ovate with a coriaceous testa, arrillate. Embryo straight and exalbuminous; the radicle next the hilum and cotyledons foliaceous and veined.

Herbaceous, annual or perennial, with tuberous or fibrous roots, succulent stems climbing by means of tendrils; the leaves covered with asperities, simple and alternate.

Geographical Relations.—Most abundant in the tropics, but found elsewhere, though very few are European.

Properties.—A generalization is made by Decandolle, that the seeds of the cucurbitaceous plants are mild and wholesome, and do not participate in the energetic properties of the rind and fruit; and it will be found that they are sweet and innocuous even in the poisonous species.

These plants often contain a powerful purgative principle, occasionally so energetic as to cause the term *poisonous* to be applied to them.

Officinal Plants.

Cucumis colocynthis.
Momordica elaterium.

25. CAPRIFOLIACEÆ.

Calyx superior, its limb 4-5 cleft. *Corolla* with divisions equal to the calyx, regular or irregular. *Stamens* equal in number to the pieces of the corolla, and alternate with them; filaments included or extended. *Ovarium* 3-4-celled, one cell having one ovule, the others many and pendulous. *Fruit* dry or fleshy, crowned by the limb of the calyx. *Seeds* solitary or many and pendulous; *testa* often horny; *embryo* straight, albumen fleshy.

Herbaceous or shrubby, with exstipulate alternate leaves. Inflorescence cymose.

Geographical Relations.—Belong more particularly to the north temperate zones, but found in China, West Indies, etc.

Properties.—Astringency of bark, beauty and fra-

grance of flower, and a cathartic or emetic property in some, are their chief characteristics.

Officinal Plant.
Sambucus nigra.

26. CINCHONACEÆ.

Calyx superior, simple, with a definite number of divisions or none, and with connate bracteæ at its base. *Corolla* superior, tubular, regular, with a definite number of divisions, which are valvate or imbricated in æstivation, and equal to the segments of the calyx. *Stamens* arising from the corolla, all on the same line, and alternate with its segments. Pollen elliptical. *Ovarium* inferior, surmounted by a disk, usually two-celled, occasionally with several cells; *ovula* numerous and attached to a central placenta, or few and erect, or ascending; *style* single, inserted, sometimes partly divided; *stigma* usually simple, sometimes divided into a definite number of parts. *Fruit* inferior, either splitting into two cocci, or indehiscent and dry, or succulent, occasionally many-celled. *Seeds* definite or indefinite; in the former case erect or ascending, in the latter attached to a central axis. *Embryo* small, oblong, surrounded by horny albumen; cotyledons thin, radicle longer, turned towards the hilum.

Trees, Shrubs, or Herbs. Leaves simple, quite entire, opposite or verticillate, with interpetiolary stipules. *Flowers* arranged variously, usually in panicles or corymbs.

Geographical Relations.—Almost exclusively found in the hotter parts of the world, especially within the tropics, where they are said to constitue 1-29th of the whole number of flowering plants.—(Above characters from Lindl.)

Properties.—Bitterness, astringency, with tonic and emetic powers, are their most marked characters; the alkaloids Cinchonia, Quinia, and Emetina are found in some of them.

Officinal Plants.

Cephælis ipecacuanha.
Cinchona cordifolia.
——— lancifolia.
——— oblongifolia.

27. VALERIANEÆ.

Calyx superior, limb dentate or cleft, membranaceous or pappose. *Corolla* tubular, inserted upon the top of the ovarium with a 5 (or 3-6) cleft-limb, the tube sometimes gibbous at the base. *Stamens* 1-5, placed on the tube of the calyx, and alternating with its lobes. *Ovarium* inferior, with one cell alone, or with two other abortive ones; *ovule* solitary and pendulous. *Fruit* dry and indehiscent, celled and seeded as the ovarium. *Embryo* of the seed straight, exalbuminous, and the radicle superior.

Herbaceous, seldom shrubby at the base, with exstipulate opposite leaves, and terminal inflorescence.

Geographical Relations.—Natives of temperate climates, with a polar rather than an equatorial tendency.

Properties.—Bitterness, stimulating and aromatic powers, with a peculiar odour, are chiefly to be observed.

Officinal Plant.

Valeriana officinalis.

28. COMPOSITÆ.

Calyx superior, quite adherent to the ovarium, from which it is inseparable; its limb modified so as to form scales, or pappus, and very seldom abortive. *Corolla* monopetalous, ligulate or tubular; when tubular five cleft, and valvate in æstivation. *Stamens* 5, placed on the tube of the corolla, and alternate with its divisions, filaments free, (rarely as in the Ambrosiæ monadelphous). Anthers narrow, two-celled, united together so as to form a tube, (Syngenesious)—rarely as in Xanthium discrete. *Ovarium* inferior, one-celled, with a single erect ovule; style simple; stigmas two, distinct or united. *Fruit* small, dry, and indehiscent (Achenium), crowned with the limb of the calyx. *Seed* solitary and erect, exalbuminous; *embryo* taper and erect, and the radicle inferior.

Herbs or shrubs with exstipulate, alternate or opposite leaves. Flowers collected upon a general receptacle, each one of the collection being termed a floret, the whole surrounded by a common involucrum. Bracteæ when present forming the chaff of the receptacle.

Geographical Relations.—They predominate in relative proportions to other flowering plants within and near the tropics, and their ratio is lowest within the arctic circle; but some divisions of the tribe are most abundant in the cold countries, and others only in the hot ones, as will presently be seen.

This family is divided into sub-tribes; the following are *Officinal*:—

Corymbiferæ.

Compositæ having tubular florets in the disk, and ligulate ones in the ray of the collection, and a non-tumid style.

Geographical Relations.—Most abundant in hot countries.

Properties.—Bitter, tonic, and stimulating; and some contain aromatic volatile oil.

Officinal Plants.

Anthemis nobilis.
——— pyrethrum.
Artemisia chinensis.
——— indica.
——— absinthium.
Inula helenium.
Tussilago farfara.

Cichoraceæ.

Compositæ having the florets ligulate, both in the ray and disk.

Geographical Relations.—Most abundant in cold climates.

Properties.—Narcotic and bitter juices exist in the members of this sub-tribe.

Officinal Plants.

Lactuca sativa.
Leontodon taraxacum.

29. LOBELIACEÆ.

Calyx superior, entire or with five divisions; *corolla* monopetalous, irregular, with five divisions, and inserted upon the calyx. *Stamens* 5, inserted upon the calyx, alternate with the divisions of the corolla; anthers united. *Ovarium* inferior, 1-3-celled; *ovules*

many; style simple; the stigma having a cup-like fringe. *Fruit* capsular, one or many-celled, and many-seeded; dehiscing at its apex. *Seed* attached either to the axis or to the lining membrane of the fruit vessel. *Embryo* straight; albumen fleshy, and the radicle towards the hilum.

Herbs or shrubs with exstipulate alternate leaves and flowers axillary or terminal.

Geographical Relations.—Countries bordering upon the tropics.

Properties.—Often acrid, and sometimes poisonous.

Officinal Plant.

Lobelia inflata.

30. ERICACEÆ.

Calyx inferior, 4-5-cleft, persistent. *Corolla* monopetalous with 4-5 divisions, marescent, imbricated in æstivation. *Stamens* equal to the number of the divisions of the corolla, or twice as many, hypogynous; anthers two-celled, the cells dry, furnished with appendages, and dehiscing by pores. *Ovarium* having at its base a disk or scales, many-celled and seeded; style simple; stigma sometimes toothed. *Fruit* capsular, with many cells, placentæ parietal. Seeds numerous and small; testa adhering to the body of the seed. *Embryo* cylindrical, albumen fleshy, radicle towards the hilum.

More or less *shrubby*, with rigid, entire, exstipulate evergreen leaves, and pedicels of the inflorescence bracteated.

Geographical Relations.—Common generally, except in Australasia; but occur in the greatest quantity at the Cape of Good Hope.

Properties.—Astringent and Diuretic.

Officinal Plant.

Arctostaphylos uva-ursi.

31. STYRACEÆ.

Calyx superior or inferior, 4-5-cleft, seldom entire, persistent. *Corolla* hypogynous, monopetalous and divided, its divisions often differing in number from those of the calyx; valvate or imbricated in æstivation. *Stamens* in 2-4 series arising from the tube of the corolla, and unequal in length; anthers innate and introrse. *Ovarium* superior or inferior, 3-5-celled, four ovules mostly in each cell, two being erect, and two pendulous. *Fruit* drupaceous, crowned with or covered by the calyx, 3-5-celled, or 1-celled by abortion. *Seeds* ascending or pendulous, according to which ovules may be abortive, albuminous; radicle long and towards the hilum, the cotyledons flat and foliaceous.

Trees or shrubs with simple exstipulate alternate leaves, and very often stellate pubescence.

Geographical Relations.—North and South America, Nepal and China; but not met with in Africa and Australia.

Properties.—More or less astringent and fragrant, and affording Benzoic acid.

Officinal Plant.

Styrax benzoin.

32. OLEACEÆ.

Calyx monosepalous, its limb 4-5-cleft, inferior. Co-

rolla hypogynous, monopetalous, (rarely wanting, as in Fraxinus.) *Stamens* two, hypogynous, alternate with the segments of the corolla ; anthers two-celled and dehiscing longitudinally. *Ovarium* simple and unconnected with a disk, two-celled, the cells two-ovuled. *Fruit* drupaceous, capsular or baccate, rarely samœriform, two-celled and two-seeded, sometimes one-seeded by abortion. *Seeds* with fleshy or horny albumen, a straight embryo, the radicle superior, and the plumula inconspicuous.

Trees or shrubs with simple exstipulate opposite leaves, and an inflorescence terminal or axillary.

Geographical Relations.—Rare in the torrid zone, and most common in the warm regions of the temperate latitudes.

Properties.—Bitterness and astringency, and the presence of much oil in the fruit vessel of the Olive are conspicuous.

Officinal Plants.

Olea europœa.
Ornus europœa.

33. APOCYNEÆ.

Calyx 5-cleft, persistent. *Corolla* monopetalous, 5-lobed, and deciduous, contorted during æstivation. *Stamens* 5, placed on the corolla, and alternate with its segments; filaments distinct; *anthers* two-celled, dehiscing longitudinally. *Ovaria* 1-2-celled, containing many ovules; styles 1-2. *Fruit* very various, capsular, drupaceous, baccate or follicular. *Seeds* having horny or fleshy albumen, the embryo straight, plumula inconspicuous, and the cotyledons foliaceous.

Trees or shrubs with lactescent juices, and exstipulate, mostly opposite leaves.

Geographical Relations.—Tropical plants, or found in countries bordering on the torrid regions.

Properties.—Acrid and stimulating, or even highly poisonous, though some members may be found innocuous.

Officinal Plant.

Strychnos nux-vomica.

34. GENTIANEÆ.

Calyx monosepalous, 4-5-cleft, inferior, persistent. *Corolla* monopetalous, hypogynous, marescent, the limb 4-5, rarely 6-8-cleft, equal, contorto-imbricate in æstivation. *Stamens* placed upon the corolla in a common series, and alternate with its divisions, and equal to them in number, or occasionally by abortion less. *Ovarium* single, 1-2-celled and ovuled. *Style* one, continuous; stigmas 1-2. *Fruit* capsular or baccate, 1-2-celled and valved, the margins of the valves turned inwards in the one-celled fruits and bearing the seeds, which in the two-celled fruits are attached to a central placenta. *Seeds* small; albumen soft and fleshy, the radicle towards the hilum.

Herbaceous, rarely shrubby plants, with simple exstipulate opposite leaves, which are sessile or petiolate : the flowers are terminal or axillary.

Geographical Relations.—To be found in all parts of the world, from the snow upon the Swiss mountains to the Cape of Good Hope.

Property.—Intensely bitter.

Officinal Plants.

Chironia centarium.
Gentiana lutea.
Menyanthes trifoliata.

35. CONVOLVULACEÆ.

Calyx monosepalous, its divisions 5, imbricated. *Corolla* monopetalous, hypogynous, regular, deciduous; its limb 5-lobed and plaited. *Stamens* 5, placed upon the base of the corolla, and alternating with its divisions. *Ovarium* 2-4-celled, seldom imperfectly unilocular, the ovules definite and erect; when more than one in each cell, they are collateral; *style* one, divided at the top, or even to the base; *stigmas* obtuse or acute. Disk annular and hypogynous. *Fruit* capsular, 1-4-celled, the valves corresponding at their edges to the margins of a free dissepiment, in general with a septicidal dehiscence, but occasionally opening transversely. *Seeds* with but little albumen, which is mucilaginous, the embryo curved, radicle inferior, and the cotyledons shrivelled.

Herbs or shrubs often twining, covered with a simple down, and having lactescent juices. The leaves are exstipulate and alternate, and the pedicels of the inflorescence have two bracteæ.

Geographical Relations.—Decidedly equatorial plants, though a few are found in Europe and North America.

Properties.—"These plants afford a good illustration of the changes wrought in the properties of the vegetables by time, and of the necessity of age to elaborate their peculiar and characteristic principles; for the

leaves, the young shoots, the flowers, and even the fruits, of the Convolvulaceæ, when young, are innocuous or almost inert, and the annual species might be eaten; but in the perennial stems and rootlets, where the sap becomes decidedly lactescent, an active resin is produced, well known for its powerful cathartic properties." —(Burnett.)

Officinal Plants.

Convolvulus scammonia.
Ipomœa jalapa.

36. SOLANEÆ.

Calyx 5, rarely 3-4-parted, persistent, inferior. *Corolla* monopetalous, inferior, with a 5, (rarely 4) cleft limb, regular or slightly irregular, and mostly plaited in æstivation. *Stamens* placed upon the corolla, alternate with its segments, and equal to them in number, but sometimes from abortion reduced to four; *anthers* dehiscing longitudinally, rarely by pores at their apex. *Ovarium* two-celled and many ovuled; style continuous; stigma entire or two-lobed. *Fruit* capsular or baccate; when capsular, with a double dissepiment, parallel to the valves; when baccate with the placentæ adhering to the dissepiments. *Seeds* many and sessile. *Embryo* seldom straight; albumen fleshy, and the radicle towards the hilum.

Herbs or shrubs with entire or divided alternate leaves, the floral ones occasionally double and approximated to each other. Inflorescence variable; pedicels destitute of bracteæ. Allied to the next tribe Scrophularineæ.

Geographical Relations.—Generally distributed over the world, but the largest proportion exist within the tropics, and but few are observed to approach the frigid

Properties.—Narcotic powers may be said to characterize this tribe, which in some members is so highly developed as to constitute them some of the most powerful poisons known. It is true that many species afford nourishment and food, and might therefore be supposed to be destitute of such noxious property; but even in many of these cases a slight degree of the general character exists, but cultivation and the culinary processes, and the great quantity of farinaceous matter over-balancing the rest, render the particular portion of the plant which is eaten, not only innocuous, but highly nutritious. The alkaloids Atropia, Solanine, and Daturine, etc., have been discovered in some species.

Officinal Plants.

Atropa belladonna.
Capsicum annuum.
Datura stramonium.
Hyoscyamus niger.
Nicotiana tabacum.
Solanum dulcamara.

37. SCROPHULARINEÆ.

Calyx inferior, often 4-5-cleft, unequal, persistent. *Corolla* monopetalous, inferior, 4-5-cleft, mostly irregular, often labiate, deciduous, imbricate in æstivation. Stamens 2-4, didynamous, placed upon the tube of the corolla. *Ovarium* superior, two-celled, many-ovuled; style one, stigma two-lobed or obtuse. *Fruit* capsular and dehiscent, rarely succulent and indehiscent, 2-3-celled, 2-4-valved, the valves entire or bifid, and the dissepiments either double, formed by the inflexed margins of the valves; or simple and entire, and then either parallel with the valves or opposite them. *Placenta* central, adnate with the dissepiment, or separate from it.

Seeds numerous; embryo within fleshy albumen, and the radicle turned towards the hilum.

Herbs, rarely shrubs, with exstipulate leaves sometimes decurrent.

Geographical Relations.—Common everywhere, being found from Melville Island to the torrid zone.

Properties.—Generally suspicious, often highly deleterious, but the culinary art can render many members esculent.

Officinal Plant.

Digitalis purpurea.

38. LABIATÆ.

Calyx monosepalous, tubular, 5-10-toothed, regular or irregular, inferior. *Corolla* monopetalous, hypogynous, bilabiate, the upper lip sometimes two,—the lower one generally three-fid. *Stamens* didynamous, placed upon the corolla, but two are sometimes abortive; anthers two-celled, sometimes apparently one-celled by the confluence of the locules at their apex. *Ovarium* deeply four-lobed, and placed upon a disk, each lobe having a solitary erect ovule. Style one, arising from the centre and base of the ovarium; stigma bifid, mostly acute. *Fruit* 1-4 small nuts, or by abortion fewer, enclosed by the persistent calyx. Seeds erect, almost exalbuminous; embryo erect, with plain cotyledons.

Herbs or undershrubs, with the branches and young stem square, and the ramifications opposite. They have exstipulate opposite leaves, and an axillary cymose inflorescence.

Geographical Relations.—Most common in the temperate latitudes.

Properties. — Abounding with volatile oils, which render them stimulant and carminative.

Officinal Plants.

Lavandula spica.
Marrubium vulgare.
Mentha piperita.
——— viridis.
——— pulegium.
Origanum vulgare.
Rosmarina officinalis.

Monochlamydeæ.

39. POLYGONEÆ.

Perianth single, inferior, imbricate in æstivation. *Stamens* definite, placed upon the bottom of the perianth, with their anthers longitudinally dehiscent. *Ovarium* superior, one-celled, with a solitary erect ovule; *styles* or *stigmas* several. *Seed* with farinaceous albumen rarely wanting or fleshy; *embryo* inverted, with the radicle away from the hilum.

Herbaceous, rarely shrubby, with simple alternate leaves, and provided with ochreate stipules.

Geographical Relations.—General over the world, from the North Pole to the West Indies.

Properties.—Astringent, acidulous, and cathartic.

Officinal Plants.

Polygonum bistorta.
Rheum palmatum.
Rheum undulatum.

40. LAURINEÆ.

Perianth single, 4-6-cleft, sometimes obsolete, imbricate in æstivation. *Stamens* definite, perigynous, in two series, the three inner stamens opposite the segments of the perianth barren or abortive, the six outer ones not so ; *anthers* adnate, 2-4-celled, with a valvate dehiscence, inner filaments, with glands at their base. *Ovarium* single, superior, with a solitary pendulous ovule. *Fruit* baccate, or drupaceous. *Seed* exalbuminous, with an inverted embryo ; cotyledons thick, fleshy, and peltate near the base.

Trees or shrubs often of a large size, with simple exstipulate alternate leaves.

Geographical Relations.—Tropical plants, few extending to the temperate regions.

Properties.—Stimulating and aromatic.

Officinal Plants.

Laurus cinnamomum.
-camphora.
-nobilis.
-sassafras.

41. MYRISTICEÆ.

Flowers diœcious. *Perianth* single, 3-cleft, valvate in æstivation.

Male Flowers.—*Stamens* 3-12, sub-perigynous ; *anthers* 2-celled, turned outwards and dehiscing longitudinally.

Female Flowers.—*Perianth* deciduous. *Ovarium* single, superior, with a solitary erect ovule ; *stigma*

slightly lobed. *Fruit* baccate, bi-valved, and dehiscent. *Seed* nut-like, covered by a many-cleft arillus ; *albumen* ruminate, somewhat fleshy ; *embryo* small, radicle inferior, and the cotyledons foliaceous.

Trees with a reddish sap, and exstipulate alternate coriaceous leaves, which when old are downy beneath. Flowers have one bractea.

Geographical Relations.—Tropics exclusively.

Properties.—The juices of the bark are acrid and irritating, the inner parts of the fruit highly stimulating.

Officinal Plant.

Myristica moschata.

42. ARISTOLOCHIÆ.

Perianth single, superior, tubular, 3-cleft ; sometimes very unequal. *Stamens* 6-18, epigynous, distinct or connate with the style. *Ovarium* inferior, 3-6-celled, with numerous ovules ; *style* simple ; *stigmas* many and radiating. *Fruit* capsular or baccate, 3-6-celled and many-seeded. *Seeds* with fleshy albumen ; *embryo* small.

Herbs or climbing shrubs, with simple alternate leaves sometimes apparently stipuled. Flowers of a dingy hue.

Geographical Relations.—Most common in intertropical America ; few are found in Europe.

Properties.—Stimulating and tonic ; some are said to have deleterious qualities.

Officinal Plants.

Serpentaria virginiana.
Asarum europœum.

43. EUPHORBIACEÆ.

Flowers monœcious or diœcious. *Perianth* single, with scaly appendages, inferior, or wanting.

MALE FLOWERS.—*Stamens* definite or indefinite, the filaments free or monadelphous. *Anthers* 2-celled, with a longitudinal dehiscence.

FEMALE FLOWERS.—*Ovarium* superior, sometimes pedicilate, 3-celled. *Styles* 3 ; *stigma* distinct or lobed. *Fruit* of 2-3 or more, dry cocca, dehiscing elastically, and separating from their common axis, each cell 1-2 seeded, the seeds pendulous. Albumen oily or fleshy, the radicle superior, and the cotyledons flat and foliaceous.

Trees, shrubs, or herbs with lactescent juices ; alternate, mostly exstipulate, simple leaves, and the flowers sometimes within a general involucrum.

Geographical Relations.—In greatest perfection in intertropical America ; but more than 100 species are to be found in Europe.

Properties.—Stimulating and acrid, and sometimes highly poisonous.

Officinal Plants.

Croton cascarilla
——— tiglium.
Euphorbia officinarum, canariensis ?
Ricinus communis (Palma christi.)

44. URTICEÆ.

Flowers monœcious or diœcious. *Perianth* single, membranous, lobed, persistent. *Stamens* definite, pery-

gynous, or hypogynous; *anthers* 2-celled, curved inwards during æstivation, and curving backwards elastically when bursting. *Ovarium* simple, superior, with a single erect ovule; *stigma* simple. *Fruit* an indehiscent nut, covered by the dry and persistent perianth. *Embryo* sometimes spiral, and sometimes exalbuminous, radicle superior, cotyledons apposite.

Herbs, shrubs, or trees, with stipulate, mostly opposite leaves, covered with glandular hairs.

Geographical Relations.—To be found in almost all situations in every part of the globe.

Properties.—Stimulating, irritating, and sometimes narcotic.

Officinal Plants.

Humulus lupulus.
Dorstenia contrajerva.

45. ARTOCARPEÆ.

Flowers monœcious. *Perianth* single, divided, the segments often membranous, or tubular, or entire. *Stamens* one or many. *Ovarium* superior (rarely inferior), 1-2-celled, ovule suspended; *style* single, filiform; *stigma* divided. *Fruit*, nuts covered by involucra, becoming more or less succulent; or a fleshy receptacle, with the nuts upon it. *Seed* suspended, solitary, the albumen sometimes wanting; embryo with its radicle towards the hilum.

Trees, shrubs, or herbs, with stipulate alternate leaves, and flowers in heads or catkins.

Geographical Relations.—Tropical plants; but a few members of the tribe are to be found without their general station.

Properties.—They have lactescent caoutchouc juices, often highly acrid, and the most virulent of all plants is to be found amongst them—the Upas tree of Java. Nevertheless the fruit of many is edible and pleasant.

Officinal Plants.

Ficus carica.
Morus nigra.

46. ULMACEÆ.

Flowers hermaphrodite, sometimes polygamous. *Perianth* single, campanulate, cleft at the edge, inferior. *Stamens* 5-placed upon the base of the perianth, erect in æstivation. *Ovarium* superior, two-celled, the ovules solitary, pendulous; *stigmas* 2, distinct. *Fruit* membranous or drupaceous, 1-2-celled. *Seed* solitary, pendulous, almost exalbuminous. *Embryo* with the radicle superior, and foliaceous cotyledons.

Trees or Shrubs, with simple, scabrous, stipulate, alternate leaves.

Geographical Relations.—Chiefly belonging to the northern temperate regions.

Properties.—Astringent.

Officinal Plant.

Ulmus campestris.

47. PIPERACEÆ.

Flowers achlamydeous, hermaphrodite, bracteate. *Stamens* definite, 2-3, rarely more; anthers erect, 1-2

celled, opening lengthwise. *Ovarium* superior, one-celled, ovule solitary and erect; stigma sessile, slightly hispid. *Fruit* somewhat fleshy, indehiscent, one-celled and seeded. *Seed* subglobose and erect, the albumen cartilaginous, "and the small *monocotyledonous* embryo is remote from the hilum, and enclosed within its persistent vitellus."

Herbaceous or shrubby, with exstipulate alternate leaves, and flowers mostly sessile.

Geographical Relations.—Essentially tropical plants.

Properties.—Aromatic and stimulating.

Officinal Plants.

Piper cubeba.
—— longum.
—— nigrum.

48. SALICINEÆ.

Flowers monœcious or diœcious. *Stamens* 2-24, free or united; anthers erect, two-celled. *Ovarium* superior, 1-2-celled, many-ovuled; *placentæ* parietal. *Style* one, sometimes wanting; *stigmas* two. *Fruit* a coriaceous capsule, 1-2-celled and 2-valved, many seeded. *Seeds* fixed near the base of the cell, hairy; albumen wanting, the radicle inferior.

Trees or shrubs with simple, stipulate, alternate leaves, and an amentaceous inflorescence.

Geographical Relations.—Most abundant in the temperate zones, though a few extend towards the tropics.

Properties.—Astringent, tonic.

Officinal Plants.

Salix alba.
—— caprea.
—— fragilis.

49. CUPULIFERÆ.

Flowers monœcious; the *stameniferous* ones collected into cylindrical or rarely roundish catkins, the *pistiliferous* ones often aggregate. *Stamens* 5-20, placed upon the base of the scaly bracteæ, or of a 4-6-cleft squamaceous perianth. *Ovaria* crowned by the rudiments of a superior single perianth, seated within a variously textured cupula, and many-celled and ovuled. *Ovules* 1-2 in each cell, pendulous. *Styles* 2-6, not much developed; stigmas distinct. *Fruit* a gland or nut, one-celled by abortion, more or less enclosed by the cupula. *Seed* pendulous and exalbuminous; embryo large, with a small superior radicle, and fleshy cotyledons.

Trees or shrubs, with simple stipulate alternate leaves, directly veined from costa to margin. Allied to Sali-

Geographical Relations.—Chiefly belonging to temperate and cold regions, though found in Africa and South America.

Properties.—Very astringent, the wood affording valuable timber.

Officinal Plants.

Quercus infectoria.
——— pedunculata.
——— robor.

50. CONIFERÆ.

Flowers monœcious or diœcious. *Stameniferous* flowers monandrous or monadelphous, arranged as an amentum. *Anthers* two or more lobed, with a dehiscence outwards; often crested. *Pistiliferous* flowers in cones or solitary. *Ovarium* open, existing as a membranaceous scale, from the base of which and internally in the cones, arises an expanded placenta, having at its base two ovules which are inverted; in a solitary flower the placenta is not expanded, and the ovules are erect; the membranes of the ovules remain open at the top. *Fruit,* a cone formed by the expanded and indurated placentæ, and often by the ovarial leaf as well; or a single nut enveloped by a succulent covering. *Seeds* with a hard crustaceous testa; *embryo* in the midst of fleshy oily albumen, with two or many cotyledons; radicles next the apex of the seed, and organically connected with the albumen.

Trees or shrubs, with linear, acerose, or lanceolate leaves, sometimes fascicled. The woody tissue marked with circular depressions.

Geographical Relations.—To be found from Hudson's Bay to Van Diemen's Land, but the chief part of the family is to be looked for in the temperate latitudes.

Properties.—Abound in resinous turpentine juices, and afford valuable timber. To some of the lower animals the leaves, etc., of the Yew are poisonous, and it is said the succulent fruit is so to man, some supposing the noxious power to be in the seed itself, others in the succulent covering. As far as my own practical experience goes, the succulent part is not only innocuous, but

sweet and pleasant to the taste, but what the seed itself may be I know not.

Officinal Plants.

Juniperus communis.
——— sabina.
Pinus abies.
—— balsamea.
—— larix.
—— sylvestris.

ENDOGENÆ.

Petaloideæ.

51. AROIDEÆ.

Flowers unisexual, arranged upon a spadix, which is sometimes naked, partial floral coverings also sometimes wanting, when present consisting of 4-5 pieces.

MALE FLOWERS.—*Stamens* definite or indefinite, very short, hypogynous; anthers one or many-celled, turned outwards.

FEMALE FLOWERS.—*Ovarium* superior, 1-3-celled, many-ovuled, ovules erect, pendulous, or parietal. *Stigma* sessile. *Fruit* dry or succulent. *Seeds* mostly albuminous, and the embryo cylindrical and erect.

Herbaceous or shrubby, sometimes without an evident stem, at others arborescent; when herbaceous often provided with a *cormus*. Leaves sheathing at the base with a parallel or reticulated system of venation, and a more or less coloured spatha is generally present.

Geographical Relations.—Much more abundant in the tropics than anywhere else.

Properties.—Acrid and sometimes highly poisonous, or aromatic and stimulating.

Officinal Plant.

Acorus calamus.

52. SMILACEÆ.

Flowers hermaphrodite or diœcious. *Perianth* single, 6-8-parted, inferior. *Stamens* 6, placed upon or near the base of the perianth, but rarely hypogynous. *Ovarium* three-celled, the cells one or many ovuled. Style simple, or three-parted. *Fruit* baccate. *Seeds* with a membranous testa; albumen fleshy and cartilaginous, and the radicle mostly distant from the hilum.

Herbs or undershrubs, often with a tendency to twine, the leaves having a reticulated venation. Allied to the next tribe Asphodeleæ.

Geographical Relations.—Sparsely though scattered generally over the globe.

Properties.—Demulcent, though sometimes acrid.

Officinal Plant.

Smilax sarza.

53. ASPHODELEÆ.

Perianth single with 6 divisions. *Stamens* 6, hypogynous, 3 of them opposite the pieces of the perianth and differing from the others, or abortive. *Ovarium* superior, 3-celled; *style* single; *stigma* entire. *Fruit* capsular, mostly 3-celled, 3-valved, with a loculicidal dehiscence. *Seeds* varying in number, with black brittle crustaceous testa; *embryo* included within fleshy albumen.

Herbaceous plants, sometimes trees, the roots fibrous or fascicled, or the plant having bulbs. Peduncles articulated in the middle. Nearly related to Smilaceæ.

Geographical Relations.—Most abundant in temperate latitudes.

Properties.—Stimulating or acrid.

Officinal Plants.

Allium sativum.
Aloe spicata.
Scilla maritima.

54. COLCHICACEÆ.—(MELANTHACEÆ.)

Perianth single, inferior, of 6 pieces, or tubular, involute in æstivation. *Stamens* 6, *anthers* extrorse. *Ovarium* 3-celled, and many seeded; style trifid; stigmas simple. *Fruit* capsular, 3-celled, sometimes with a loculicidal dehiscence. *Seeds* with a membranous testa and dense fleshy albumen.

Herbaceous plants with fibrous roots, sometimes a cormus, and the flowers arising from below the ground.

Geographical Relations.—Most abundant in northern latitudes.

Properties.—Acrid, often highly virulent. The alkaloid Veratrine is found in some.

Officinal Plants.

Colchicum autumnale.
Veratrum album.
Helonias officinalis, (Veratrum sabadilla.)

55. PALMÆ.

Flowers hermaphrodite or polygamous, arranged on a spadix, and besides being covered by the general one or many valved spathaceous envelope, possessing separate perianths.. *Perianths* single, 6-parted in two series; the divisions of the outer are smaller than those of the inner series, which are often considerably connate. *Stamens* definite, most frequently 6, placed upon the base of the perianth. *Ovarium* 1-3-celled, cells one ovuled. *Fruit* baccate or drupaceous with fleshy or fibrous mesocarp. *Embryo* small, cylindrical, or turbinate, various in its situation, but usually distant from the hilum, enclosed in a hollow of the albumen, and covered by an operculum. *Albumen* cartilaginous, and either ruminated or with a central (rarely a ventral) cavity, the plumula is scarcely to be seen, and the cotyledonary extremity of the embryo is much enlarged in germination.

Trees as regards size and general appearance, sometimes branched. Stem covered with scales formed by the persistent bases of the leaves, which latter are terminal, pinnate, or flabelliform, and plaited in vernation. Spadix branched.

Geographical Relations.—Chiefly intertropical plants, few being found even in the southern parts of the temperate zones, and only one species in Europe.

Properties.—The different members of this great family are applied to very various purposes, both food and clothing being afforded by many. The cellular tissue of the trunk of some abounds in amylaceous matter.

Officinal Plant.

Sagus rumphii.

56. DRYMYRHIZEÆ.—(SCITAMINEÆ).

Calyx superior, tubular, 3-cleft. *Corolla* tubular, with six segments in two series, irregular. *Stamens* 3, distinct, but reduced to one by abortion of the two lateral stamens, the remaining one placed opposite the labellum of the corolla ; filament sometimes extended as an appendage to the anther ; lobes of the anther often embracing the upper part of the style. *Ovarium* three celled or imperfectly so ; ovules numerous on a central placenta. *Fruit* capsular, rarely fleshy, three-celled, many seeded. Albumen farinaceous or horny.

Herbaceous plants with a creeping rhizoma sometimes jointed ; the leaves alternate and sheathing. Allied to the next family Marantaceæ.

Geographical Relations.—Tropical plants.

Properties.—Aromatic and stimulating.

Officinal Plants.

Alpinia cardamomum.
Zingiber officinale.

57. MARANTACEÆ.

The members composing this tribe have been separated from Drymyrhizeæ, from having the two lateral segments of the inner series of the corolla different from each other, the filament petaloid, the anther one-celled, and from being destitute of pungency.

Officinal Plant.

Maranta arundinaceæ.

Glumaceæ.

58. GRAMINEÆ.

Flowers glumaceous, generally hermaphrodite, but sometimes monœcious or polygamous. Bracteæ generally two in number (two-valved); the valves alternate, sometimes single, (one-valved); mostly unequal. Perianthium of two pieces or valves, alternate, the outer or lower valve sometimes bifid or aristated, or both. Scales 2-3, sometimes absent. *Stamens* hypogynous, (often 3), with versatile anthers. *Ovarium* simple; styles one to three, but mostly two in number; stigmas often plumose. *Fruit* a caryopsis, (the fruit dry and indehiscent, the endocarp adhering to the integuments of the seed). "*Embryo* lying on one side of the albumen at the base, lenticular, with a broad cotyledon and a developed plumula; and occasionally, but very rarely, with a second cotyledon on the outside of the plumula, and alternate with the usual cotyledon." Albumen farinaceous.

Herbaceous, generally simple, sometimes branched, rarely shrubby; stems or culms fistulose, covered with an external siliceous layer, and closed at the joints or nodii. Leaves one to each joint, with a sheath slit longitudinally at one side, having a membranous appendage (ligule) at its summit. Flowers small, panicled, spiked, or racemed; secondary spikes termed locustæ.

Geographical Relations.—Of the nearly 2000 species known, about 800 are tropical, and from 1150 to 1200 are extra-tropical.

Properties.—Farinaceous, saccharine, and demulcent; one species is noxious.

Officinal Plants.

Avena sativa.
Hordeum distichum.
Saccharum officinarum.
Triticum hybernum.

CRYPTOGAMIA.

Ætheogamia.

59. FILICES.

Stems present, either creeping below or upon the surface of the ground like a rhizoma, or rising above it and appearing like the stems of *trees*. *Fronds* or leaf-like expansions, simple or compound, or more or less divided, with a dichotomously reticulated system of venation; circinate in vernation. Stomata present. *Reproductive organs* placed in masses called sori, upon the dorsal surfaces of the fronds or upon their margins. *Sori* of various shapes, covered in many cases by a cellular envelope or *indusium*, which dehisces. Masses of sori composed of numerous cases or *thecæ*, each thecæ provided with an elastic ring or *annulus*, or destitute of it, aud form either a single cavity, or are divided into several compartments. Reproducing germs or *sporules* contained within the thecæ.

(According to Presl, the male organs or anthers are lenticular, oval or globose stipitate bodies filled with an opaque substance, and appearing in the sori amongst the congregated thecæ, but are only to be seen when in a very young condition. After the bursting of these bodies, the opaque matter being ejected, they collapse and dry).

Geographical Relations.—Abounding within the tropics, and decreasing both in size and number towards the poles.

Properties.—Their most general character is astringency.

Officinal Plant.

Aspidium filix-mas.

Amphigamia.

60. LICHENES.

Aerial perennial plants varying exceedingly in their form, appearance, and texture, always constituting a *thallus, crust,* or *frond,* (universal receptacle, Ach.) which frequently spreads horizontally upon soil, rocks, stones, the bark of trees and dead wood, and is pulverulent, membraceous, coriaceous, gelatinous, filamentous, and variously lobed and divided; sometimes it is erect, fructiculose, and much branched, at other times pendent. Variously coloured, rarely green, often the substance is simply composed of cellules, at other times the cellules are mixed with fibres. Imperfect roots are sometimes formed, but more for the purpose of fixing the plant to its place of growth, than of deriving nutriment, which appears to be afforded solely by the air. *Fructification* is of two kinds, a powdery substance forming indeterminate masses or collected into more or less evident receptacles; and what is considered a higher state of fructification, apothecia or partial receptacles, which have received different names, according to their forms *scutellæ, peltæ, lirellæ,* etc., etc.; these for the most part are sessile, perennial, and contain a somewhat

waxy plate or layer, in which are imbedded *sporules* inclosed in little membranous *thecæ.*—(Hooker).

Geographical Relations.—To be found from the equator to the poles; but are plants rather of the northern than southern regions.

Properties.—Mucilaginous and nutritive from their amylaceous matter; but sometimes bitter. They afford likewise good dyes.

Officinal Plant.

Cetraria islandica.

61. FUNGI.

Aerial plants composed chiefly of cellular tissue, but which sometimes has fibrous tissue intermixed with it. *Thallus* varying in texture, being soft, leathery, or waxy, etc.; and often coloured in the most showy and brilliant manner, though seldom green, which colour, when it does occur, is of a lurid metallic tint; but sometimes wanting. *Spores* or reproductive germs always present; but sometimes unconnected by any common receptacle or thallus; in a few cases quite naked, but mostly covered or enclosed by an *hymenium, perithecium,* or *peridium.*

Plants found upon decaying animal or vegetable matter in abundance, and upon living vegetables, and growing upon or quite beneath the surface of the earth, varying in size from a minute cellule to a mass of two or three feet in diameter.

Geographical Relations.—Chiefly affecting northern latitudes and the northern parts of the temperate zone

Within the compass of a square furlong in Sweden, Fries states that he found no less than two thousand species.

Properties.—Sometimes wholesome, at other times most virulently poisonous.

Officinal Plant.

Acinula clavus.

TABLE OF OFFICINAL PLANTS, ETC.

GENERAL NAME OF THE OFFICINAL SUBSTANCE.	PLANT YIELDING IT.	NATURAL FAMILY OF THE PLANT	REGION FROM WHENCE IS PROCURED.
Aconite	Aconitum paniculatum	Ranunculaceæ	Cultivated in England.
Almonds, bitter and sweet	Amygdalus communis var. β, γ.	Rosaceæ	Africa.
Aloes	Aloe spicata	Asphodeleæ	Cape of Good Hope.
Ammoniac	Dorema ammoniacum	Umbelliferæ	Persia.
Aniseed	Pimpinella anisum	Umbellifeæ	Egypt.
Arrow-root	Maranta arundinacea	Marantaceæ	West Indies.
Assafœtida	Ferula assafœtida	Umbelliferæ	Persia.
Asarabacca	Asarum europœum	Aristolochiæ	Indigenous.
Balsam of Copaiba	Copaifera officinalis	Leguminosæ	South America.
——— Peru	Myroxylon peruiferum	ditto	ditto.
——— Tolu	ditto	ditto	ditto.
Bark—grey	Cinchona lancifolia?	Cinchonaceæ	ditto.
Bark—red	Cinchona oblongifolia?	ditto	ditto.
Bark—yellow	Cinchona cordifolia?	ditto	ditto.
Barley	Hordeum distichum	Gramineæ	Cultivated in England.
Belladonna	Atropa belladonna	Solaneæ	Indigenous.
Benzoin	Styrax benzoin	Styraceæ	Sumatra.
Broom	Cytisus scoparius	Leguminosæ	Indigenous.
Buchu	Diosma crenata (Barosma)	Diosmeæ	Cape of Good Hope.
Buck-bean	Menyanthes trifoliata	Gentianeæ	Indigenous.
Buck-thorn	Rhamnus catharticus	Rhamneæ	Indigenous.

GENERAL NAME OF THE OFFICINAL SUBSTANCE.	PLANT YIELDING IT.	NATURAL FAMILY OF THE PLANT.	REGION FROM WHENCE IT IS PROCURED.
Cajeput	Melaleuca leucadendron	Myrtaceæ	Amboyna.
Calumba	Menispermum palmatum	Menispermaceæ	Southern Africa
Camboge	Stalagmitis cambogioides	Guttiferæ	Ceylon.
Camphor	Laurus camphora	Laurineæ	East Indies.
Canella	Canella alba	Meliaceæ	West Indies.
Capsicum	Capsicum annuum	Solaneæ	East Indies.
Cardamine	Cardamine pratensis	Cruciferæ	Indigenous.
Cardamoms	Alpinia cardamomum	Drymyrhizeæ	East Indies.
Caraway	Carum carui	Umbelliferæ	Indigenous.
Cascarilla	Croton cascarilla	Euphorbiaceæ	Bahamas.
Castor oil	Ricinus communis	Euphorbiaceæ	East and West Indies.
Catechu	Acacia catechu	Leguminosæ	East Indies.
Chamomile	Anthemis nobilis	Compositæ	Indigenous.
Cinnamon	Laurus cinnamomum	Laurineæ	Ceylon.
Cloves	Caryophyllus aromaticus	Myrtaceæ	Moluccas.
Colchicum	Colchicum autumnale	Colchicaceæ	Indigenous.
Colocynth	Cucumis colocynthis	Cucurbitaceæ	Turkey, Cape of Good Hope.
Colts-foot	Tussilago farfara	Compositæ	Indigenous.
Contrajerva	Dorstema contrajerva	Urticeæ	South America.
Coriander	Coriandrum sativum	Umbelliferæ	Indigenous.
Croton oil	Croton tiglium	Euphorbiaceæ	Moluccas.
Cubebs	Piper cubeba	Piperaceæ	Java and Guinea.
Cummin	Cuminum cyminum	Umbelliferæ	Egypt.
Cusparia	Galipea cusparia	Diosmeæ	South America.
Dandelion	Leontodon taraxacum	Compositæ.	Indigenous.
Digitalis	Digitalis purpurea	Scrophularineæ	Indigenous.

GENERAL NAME OF THE OFFICINAL SUBSTANCE.	PLANT YIELDING IT.	NATURAL FAMILY OF THE PLANT.	REGION FROM WHENCE IS PROCURED.
Dulcamara	Solanum dulcamara	Solaneæ	Indigenous.
Elaterium	Momordica elaterium	Cucurbitaceæ	Cultivated in England.
Elder	Sambucus nigra	Caprifoliaceæ	Indigenous.
Elecampane	Inula helenium	Compositæ	Indigenous.
Elm	Ulmus campestris	Ulmaceæ	Indigenous.
Ergot of Rye	Acinula clavus	Fungi	
Euphorbia	Euphorbia officinarum	Euphorbiaceæ	Africa.
Fennel	Fœniculum vulgare	Umbelliferæ	Indigenous.
Fern	Aspidium filix-mas	Filices	Indigenous.
Fig	Ficus carica	Artocarpeæ	Persia.
Flour	Triticum hybernum	Gramineæ	Cultivated in England.
Galban	Galbanum officinale	Umbelliferæ	Cape of Good Hope.
Galls	Quercus infectoria	Cupuliferæ	Aleppo.
Garlick	Allium sativum	Asphodeleæ	Cultivated in England.
Gentian	Gentiana lutea	Gentianeæ	Swiss Alps.
Ginger	Zingiber officinale	Drymyrhizeæ	East Indies.
Gum arabic	Acacia vera	Leguminosæ	Africa.
—— tragacanth	Astragalus verus	Leguminosæ	Persia.
Guaiac	Guaiacum officinale	Zygophylleæ	South America.
Hellebore-black	Helleborus niger	Ranunculaceæ	Cultivated in England.
Hellebore-white	Veratrum album	Melanthaceæ	North of Europe.
Hop	Humulus lupulus	Urticeæ	Indigenous.
Horehound	Marrubium vulgare	Labiatæ	Indigenous.

GENERAL NAME OF THE OFFICINAL SUBSTANCE.	PLANT YIELDING IT.	NATURAL FAMILY OF THE PLANT.	REGION FROM WHENCE IT IS PROCURED.
Hyoscyamus	Hyoscyamus niger	Solaneæ	Indigenous.
Iceland moss	Cetraria islandica	Lichenes	Iceland.
Ipecacuanha	Cephælis ipecacuanha	Cinchonaceæ	North America.
Jalap	Ipomœa jalapa	Convolvulaceæ	South America.
Juniper	Juniperus communis	Coniferæ	Indigenous.
Kino	Pterocarpus erinaceus	Leguminosæ	Africa.
Laurel	Laurus nobilis	Laurineæ	Cultivated in England.
Lavender	Lavandula spica	Labiatæ	Cultivated in England.
Lemon	Citrus medica	Aurantiaceæ	Spain, Italy.
Lettuce	Lactuva sativa	Compositæ	Cultivated in England.
Linseed	Linum usitatissimum	Lineæ	Indigenous.
Lobelia	Lobelia inflata	Lobeliaceæ	America.
Logwood	Hematoxylon campechianum	Leguminosæ	South America.
Mallow	Malva sylvestris	Malvaceæ	Indigenous.
Mallow-marsh	Althæa officinalis	Malvaceæ	Indigenous.
Manna	Ornus europœa	Oleaceæ	South of Europe.
Marjoram	Origanum vulgare	Labiatæ	Indigenous.
Mastic	Pistacia lentiscus	Anacardiaceæ	South of Europe.
Mezereon	Daphne mezereon	Thymeleæ	Cultivated in England.
Mustard	Sinapis alba	Cruciferæ	Indigenous.
Myrrh	Balsamodendron myrrha	Burseraceæ	Arabia felix.

GENERAL NAME OF THE OFFICINAL SUBSTANCE.	PLANT YIELDING IT.	NATURAL FAMILY OF THE PLANT.	REGION FROM WHENCE IT IS PROCURED.
Nutmeg	Myristica moschata	Myristiceæ	Moluccas.
Nux vomica	Strychnos nux vomica	Apocyneæ	East Indies.
Oak	Quercus pedunculata	Cupuliferæ	Cultivated in England.
Olibanum	Boswellia serrata	Burseraceæ	India.
Olive	Olea europœa	Oleaceæ	Spain.
Opium	Papaver somniferum	Papaveraceæ	Persia.
Opoponax	Pastinaca opoponax	Umbelliferæ	Levant, etc.
Pellitory	Anthemis pyrethrum	Compositæ	Cultivated in England.
Penny-royal	Mentha pulegium	Labiatæ	Indigenous.
Peppermint	Mentha piperita	Labiatæ	Indigenous.
Pepper—long	Piper longum	Piperaceæ	East Indies.
Pepper—black	Piper nigrum	Piperaceæ	East Indies.
Pimento	Eugenia pimenta	Myrtaceæ	West Indies.
Pitch	Pinus abies	Coniferæ	America, Norway
Pomegranate	Punica granatum	Myrtaceæ	South of Europe
Prune	Prunus domestica	Rosaceæ	South of Europe.
Quassia	Quassia excelsa	Simarubeæ	West Indies.
Rhatany	Krameria triandra	Polygaleæ	Java.
Rhubarb	Rheum palmatum et undulatum	Polygoneæ	Russian Tartary.
Rose	Rosa centifolia et gallica	Rosaceæ	Cultivated in England.
Rosemary	Rosmarinus officinalis	Labiatæ	Cultivated in England.
Rue	Ruta graveolens	Rutaceæ	Cultivated in England.

GENERAL NAME OF THE OFFICINAL SUBSTANCE.	PLANT YIELDING IT.	NATURAL FAMILY OF THE PLANT.	REGION FROM WHENCE IT IS PROCURED.
Sabadilla	Helonias officinalis	Colchicaceæ	South America.
Sagapenum	Unknown		Alexandria.
Sago	Sagus rumphii	Palmæ	
Sarsaparilla	Smilax sarza	Smilaceæ	America.
Sassafras	Laurus sassafras	Laurineæ	America.
Savine	Juniperus sabina	Coniferæ	Cultivated in England
Scammony	Convolvulus scammonia	Convolvulaceæ	America.
Senega	Polygala senega	Polygaleæ	America.
Senna	Cassia senna	Leguminosæ	Alexandria.
Snake-root	Aristolochia serpentaria	Aristolochiæ	South America.
Spearmint	Mentha viridis	Labiatæ	Indigenous.
Squill	Scilla maritima	Asphodeleæ	Austria.
Staves-acre	Delphinium staphisagria	Ranunculaceæ	Istria.
Sugar	Saccharum officinarum	Gramineæ	West Indies.
Tamarind	Tamar-indus indica	Leguminosæ	West Indies.
Tansy	Tanacetum vulgare	Compositæ	Indigenous.
Tobacco	Nicotiana tabacum	Solaneæ	America, etc.
Tormentilla	Tormentilla officinalis	Rosaceæ	Indigenous.
Turpentine	Pinus sylvestris	Coniferæ	Indigenous.
Uva-ursi	Arctostaphylos uva-ursi	Ericaceæ	Indigenous.
Valerian	Valeriana officinalis	Valerianeæ	Indigenous.
Wine	Vitis vinifera	Ampelideæ	Spain.

INDEX.

DIVISION 1.—Anatomy.

DIVISION II.—Morphology.

DIVISION III.—Physiology.

DIVISION IV, (*Misprinted* 3).—PATHOLOGY.

DIVISION V, (*Misprinted* 4.)—SYSTEMATOLOGY.